CLINICAL CONGRESS OF SURGEONS SEVENTH ANNUAL SESSION, Philadelphia, Oct. 23-28, 1916

ANNUAL SUBSCRIPTION: UNITED STATES AND CANADA, $10.00; FOREIGN, $12.00 (£2 10s.)

Volume XXIII SEPTEMBER, 1916 Number 3

Surgery, Gynecology and Obstetrics

WITH

International Abstract of Surgery

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John Benjamin Murphy

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PRESIDENT, AMERICAN MEDICAL ASSOCIATION, 1911

PRESIDENT, CLINICAL CONGRESS OF SURGEONS
OF NORTH AMERICA, 1914

FOUNDER AND REGENT
AMERICAN COLLEGE OF SURGEONS

HONORARY FELLOW
ROYAL COLLEGE OF SURGEONS OF ENGLAND

DIED AUGUST 11, 1916

An Appreciation

DR. JOHN B. MURPHY possessed those intellectual, physical, and personal qualities which make a surgeon. After graduating from Rush Medical College in 1879 and serving an interneship in Cook County Hospital, Dr. Murphy went to Vienna and came under the direction of that master surgeon, Billroth, then at the height of his great career. Billroth was a man of charming personality and most original mind, and his students today fill the chairs of surgery in many Teutonic universities. During these formative years of Dr. Murphy's European sojourn, Albert was also one of his favorite teachers. Few men ever equaled Albert's ability to logically present clinical surgery. Fired with zeal, Dr. Murphy returned home and came under the influence of the father of modern surgery in the West — Christian Fenger — who was unequaled as a teacher of surgical pathology. Dr. Murphy combined the qualities of Billroth, Albert, and Fenger.

The reputation of a surgeon, in the final analysis, must rest upon (1) originality, (2) teaching by word of mouth, (3) teaching by the printed word, and (4) surgical judgment and operative skill.

Dr. Murphy had a marvelously fertile and original mind. Possessing a brilliant surgical imagination, he early deviated from the beaten paths and invaded new territory, and yet with such acumen that nothing which he originated has failed to live. Like those of the great musicians, his productions are still masterpieces; they mark epochs in surgical progress. He made the experimental laboratory a hand-maiden to surgery and carefully investigated every detail of his constructive work by animal experimentation before applying it to man.

As a teacher of surgery by word of mouth he had, in my opinion, no equal. Clear and logical, he started with facts about which there could be no dispute, progressed from these facts toward new ground, yet along pathways more or less familiar to all, and finally, taking us by the hand, so to speak, he led the way to new truths by the light of his surgical genius.

As a writer he was prolific. His early work was in the field of abdominal surgery. The Murphy button taught us to solve many problems connected with gastro-intestinal surgery. His monograph on "Ileus" still stands a monument to his scientific ability. The history of surgery of the appendix, pelvis, and upper abdomen, as well as of the kidney, shows evidences of his genius. Dr. Murphy next developed surgery of the lungs and, in the oration on surgery delivered at Denver in 1898, he laid the foundation for modern surgery of the lungs; so far ahead of his time was this that we have only of late awakened to an appreciation of its value. Dr. Murphy's work on surgery of the nervous system helped to lay the foundation for the present practice, and again his latest work on bones and joints, in which he was engaged during the closing years of his life, are perhaps the greatest contributions to these subjects of our generation.

Dr. Murphy was skillful as an operator, of fine judgment, humane, sane, sound, and free from fads. What surgeon has not felt, on seeing him operate, a just pride in the science and art of surgery, and expressed the hope that in the event he or a member of his family must have an operation, so good a surgeon as Dr. Murphy might perform it?

The American surgical profession has lost its leading spirit. In Dr. Murphy's death at the age of fifty-eight, well may we regret the unfilled twelve years which go to make up the allotted span of man. And yet, when we review what he has done, we freely acknowledge that even in the time the light lasted, he accomplished more than any other surgeon of his time.

William J. Mayo

Our Chief of Staff

JOHN B. MURPHY was the underlying support of SURGERY, GYNECOLOGY AND OBSTETRICS and the INTERNATIONAL ABSTRACT OF SURGERY from the time of their inception to the day of his death. He was the inspiration for every move of merit that SURGERY, GYNECOLOGY AND OBSTETRICS has stood for and fathered. He was the adviser, personal friend, and aid to the editor and his associates, and, when difficult problems arose, his strength of character, his personality, and his power of vision all were contributed unsparingly toward right solutions. Dr. Murphy was one of the few who maintained at the first conception of the Journal that it would succeed if it were comprehensive and served the needs of the surgeon. And to this ideal he inseparably attached his program of personal energy and financial support.

When the Clinical Congress was developed through an informal invitation of the Journal, both the surprising response to this call and the far-reaching benefits it offered to surgeons fired his imagination and he declared for a permanent organization. Through his force the organization became swiftly the great clinical society that he predicted for it; it served the practical needs of the surgeon.

When at the third session of the Clinical Congress some discussion arose as to whether America should have a great society for the advancement of surgery, it was Dr. Murphy who was recognized by the President of the Congress to second the proposals of the officials. On that occasion he made such a compelling appeal that every man in the audience grasped not only the great vision but also how the vision could become fact. On his motion, then, the committee of nine was authorized and the American College of Surgeons ceased to be a dream and became a certainty.

These three organizations, which have become powerful agencies throughout the medical world, were but important incidents in the constructive mind of Dr. Murphy. But each of these organizations owes its existence to his enthusiastic support, to his uncompromising determination that each represent fundamentals of progress in surgery which are worth while.

The personal loss to the staff of the Journal is too great, and at this time the heart is too full to dwell here on more than the mountain peaks of his service. The details of a wonderful association and friendship are sacred and the writer mourns the loss of the greatest friend he ever knew.

John Benjamin Murphy

"He went away as he had lived, nobly careless of himself and thinking only of the things he had undertaken to do."

BY thought, by action, and by self-discipline, he trained a body and mind given by a pure inheritance into a strong physique, an acute brain, and a dominating personality.

With unsatisfied industry he acquired the knowledge of his art and made his mind a possessor of the recorded deeds of his confrères of the world.

He learned surgery serving with indefatigable energy the needs of helpless humanity, and taking counsel of his fellow-workers in every field, old and new, in which his profession was practiced.

He had a creative mind, trained to investigate facts, and suspicious of traditions, with a courage to bring forth the new; a judicial mind that judged so correctly the value of the new his genius brought forth that the things he wrought were recognized by science as enduring principles of surgery.

He imparted to others his knowledge from a great storehouse by an irresistible enthusiasm, begotten by his appreciation of truth, in a way that appealed to the mind, the conscience, and the responsibility of his hearer, and that made him the impelling teacher of his time.

His experiments were made in the laboratory, in the dead house, and in the animal operating room. He thus proved theories by facts, but never at the expense of those he served.

The impelling text of his life—in experiments, in writing, in the practice of his art, and in his burning utterances as a teacher—was: "Have uppermost in your mind the welfare of the individual who entrusts his life to your care."

He worked and pleaded for higher standards. He was democratic in his methods. He condemned complacent entrenched interests as a bar to progress. His life was a protest against ignorance and pretense. He believed that most things worth while came from those not bound by tradition. He encouraged the beginner and listened to the obscure.

He labored with more and more concentration of effort, as the wonders and possibilities of his task were revealed, trusting his strong body inured by abstemiousness and continued work to perform the almost superhuman task imposed upon it, and then the body broke, and his life, in the fullness of its power, was sacrificed. "Greater love hath no man than this, that a man lay down his life for his friends."

He loved God and expressed this love in his work for men and little children. He was the devoted father, the beloved husband, the staunch friend, and the inspirer of all who came within his influence.

He was the human man, developing, through many years of self-discipline, indefatigable work, untold sacrifice, and desire of highest service, into the superman— the high priest of the most exacting profession.

SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME XXIII SEPTEMBER, 1916 NUMBER 3

THE EXTENDED OPERATION FOR CARCINOMA OF THE UTERUS[1]

BY REUBEN PETERSON, M.D., F.A.C.S., ANN ARBOR, MICHIGAN
Professor of Obstetrics and Gynecology, University of Michigan

FOUR years ago, at the Baltimore meeting of this Society, it was my privilege to take part in the symposium on uterine cancer. In that paper I said that while I believed in the radical abdominal operation, greater experience had not made me any more confident that its primary or ultimate results would be favorable to the next patient operated upon. I have had no reason to change this opinion during the past four years. Unfortunately, added experience has strengthened my belief that the extended operation for cancer of the uterus is an exceedingly dangerous operation, always attended by a high primary mortality, and that it is no operation for inexperienced hands. However, it must be continually kept in mind that in spite of these defects, today it is the only method, unless it be the extended vaginal method, which holds out to the patient with carcinoma of the uterus a reasonable hope of complete cure. I make this statement in advance of what will be revealed by the other essayists as to the results of radium or other methods of treatment. No one will be more glad to discard the radical abdominal method than will I, if I can be shown that more patients can be ultimately cured by less dangerous methods.

To arrive at any just conclusions regarding the radical operation it is absolutely necessary that the primary and ultimate results be considered together. Every one who has performed the operation realizes how easy it is to dodge the issue and perform what Clark has well called "makeshift" operations. What is easier than to avoid going beyond a mass in one or the other broad ligament in which the ureter is embedded and tying the uterine artery close to the uterus as in the ordinary panhysterectomy? This choosing the easiest way may save the operator a primary death but it just as surely dooms the patient to a continuance of the disease and ultimate death as did the old vaginal hysterectomy. Such an operation is not an extended operation for cancer of the uterus and should not be classified as such. If it be not excluded it will show in the final summing up, for if the patients be kept track of, they will be found to have died of so-called recurrences which in reality were no recurrences at all since the disease was not removed.

I would not be understood as asserting that an operator has not a perfect right to dodge the issue and save his patient primarily when he feels that a prolongation of the operation means but one thing — death. However, I do insist that such operations should not be classed among the extended operations for carcinoma of the uterus, for if so included they give a false conception of the primary mortality; in fact, it is not enough to state that such and such operations were radical. If they be radical it will be demonstrated in the ultimate results — the number of patients surviving five years or more. If these results be favorable, then and only then will we

[1] Read at the meeting of the American Gynecological Society, Washington, May 10, 1916.

be convinced that the operations were indeed radical.

Looked at in another way, the burden of proof is upon the radical abdominal operator to show, if his ultimate results are poor, why he chose the abdominal in preference to the safer vaginal route as a palliative procedure, because it is a palliative method if it cannot be shown that quite a percentage of patients are alive and well after five years. We may or may not know at the completion of a certain radical operation whether it has accomplished its purpose. If macroscopic cancerous areas have been left behind, it should be stated in any classification of radical operations for cancer of the uterus that in so many cases the operations were performed, while in other cases, although the radical operation was attempted, it had to be abandoned on account of an extension of the disease not realized when the operation was begun.

It is different with microscopic areas of cancer. Here it is perfectly justifiable for the operator to conclude that he has performed the radical operation, if the principles of the technique, such as ligation of the uterine arteries external to the ureters and removal of a long cuff of vaginal tissue below the cervical cancer, be carried out. In reality, excluding implantation metastases, an avoidable error of technique, every "recurrence," after a radical abdominal operation for cancer of the uterus, is evidence that the operator did not accomplish his purpose, although he may have been justified in thinking at the time of the operation that he had.

PRIMARY RESULTS

As in the former paper I shall still include cases of cancer of the fundus with those of the cervix for both classes of cases have been subjected to the radical abdominal operation. However, in order that the operative results may be compared with others, the primary and end-results of carcinoma of the fundus and of the cervix have been considered separately. Since the 1912 meeting I have not employed the extended operation upon a single case of carcinoma of the fundus but have depended upon the ordinary panhysterectomy. Since 1912 there have been 14 cases of ordinary hysterectomy for carcinoma of the fundus with two primary deaths or a primary mortality of 14 per cent. There have been two recurrences.

This is a worse showing than in the former report where there were 11 radical operations for carcinoma of the fundus with one operative death or a primary mortality of 9 per cent, and only one recurrence in the remaining 10 cases. It confirms the position of Weibel who bases his conclusions upon 67 cases of carcinoma of the fundus from Wertheim's clinic. These cases were operated upon by different methods, radical abdominal, simple abdominal panhysterectomies, supravaginal amputations, and vaginal hysterectomies. While the radical abdominal method was attended by the highest primary mortality, it also showed the highest percentage of ultimate recoveries, notwithstanding the fact that this method was employed in only the most advanced cases. In 31 cases the regional lymph-glands were found to be involved five times or in 16 per cent.

The only recurrence in 10 cases of cancer of the fundus surviving the radical operation reported in my last series occurred in a patient where regional lymph-glands showed carcinoma. Just because our results are better in carcinoma of the fundus after ordinary panhysterectomy should not blind us to the fact that only by the very radical operation can the individual patient be given the best chance of a non-recurrence. There has been but a single recurrence in 10 patients surviving the radical abdominal operation for cancer of the fundus, although these patients are all beyond the five-year limit. Hereafter, I shall perform the radical operation upon all operable cancers of the fundus.

I had reason to think that greater experience with the operation under discussion, carrying with it necessarily a reduction in the time required to complete the operative procedure, would lower the primary mortality in my hands. This expectation was further justified by my results, since there were only 4 deaths in the last 37 cases in the last series, or a mortality of 10.8 per cent. But my hopes were doomed to disappointment since the mortality has been increased from

22.5 per cent to 25.4 per cent, there being 15 deaths in a total of 59 cases.

It is rather a thankless task to attempt to explain these latest deaths, three of which resulted from shock and two from peritonitis. The same technique was employed as with the previous cases, but with far worse results. I had thought it possible to judge with a fair degree of precision whether the cancerous process had advanced beyond the point where it was fairly safe to attempt the radical removal of the uterus, especially if the final decision was reserved until after the abdomen was opened. But I judged incorrectly in these cases since the patients died of shock, the result of prolongation of the operation for a time sufficient to overcome the difficulties met with. The two patients dying from peritonitis should have been saved but were not in spite of all precautions to avoid sepsis.

It must be constantly borne in mind that every case of cancer of the uterus must be studied as an individual problem, so far as surgical treatment is concerned. First of all, is the disease so far advanced as to preclude any hope that the patient can be cured by radical operation? Long ago it was determined that while much could be learned of the extent of the disease through careful vaginal and rectal palpation, the final decision had to be made after the abdomen was opened. Only in this way is it possible to determine definitely the nature of induration to the sides of the uterus, whether due to cancer or to pelvic inflammation.

If the parametria be involved by cancer well outside of the uterus, it must be decided from the extent of the involvement and the other factors in the case whether to attempt the removal of the carcinoma radically or employ some palliative procedure. The other factors in the case are the age of the patient, not in years always, but the actual age as revealed by the condition of the kidneys, the heart, and the blood-vessels. Cancer patients do not stand prolonged operations well; especially is this true when the uterus is the seat of the cancer. This is easily demonstrated when such patients are compared with women of the same age who have had to undergo prolonged operations for other conditions; in other words, a patient with cancer of the uterus is a poor risk at best. Where the kidneys and vascular system are impaired it may be folly to subject her to such a serious operation, because of the slight chance of her primary recovery. It may be far better for the patient to prolong her life as much as possible by palliative measures.

TABLE I.— Radical Abdominal Operation for Cancer of the Uterus. Primary Mortality in 59 Cases; 48 Cases of Cancer of the Cervix, 11 Cases of Cancer of the Fundus. July, 1912, to October, 1915.

Total number of cases	59
Total number of deaths	15
Total primary mortality	25.4%
Primary mortality, 48 cervix cases	29.1%
Primary mortality, 11 fundus cases	9.0%

TABLE II.— Causes of Primary Deaths — 15 Cases.

Shock	7
Shock and hæmorrhage	2
Peritonitis	4
Embolus	2
Total	15

Using our best judgment we may and do make mistakes, and attempt the impossible with the result that the patient does not recover primarily. But it is the height of folly in my opinion to speak continually as if the entire question of primary mortality after the radical operation for carcinoma of the uterus depended solely upon the extent of the disease. As a matter of fact that is only one of the factors in the problem, the others being nearly if not just as important.

The responsibility of what the patient will decide rests after all with the surgeon. The victim of cancer of the uterus above everything else wants to be cured, not only primarily, but so that there will be no return of the disease. She may be willing to take a great risk if there be a fair chance of being cured, but not one woman in fifty but will choose palliative measures and the prolongation of life, rather than an almost hopeless operation so far as primary results are concerned. It is hardly fair for the surgeon to justify his course of taking large chances with the life of an individual cancer-of-the-uterus patient by saying that inasmuch as without an operation she is doomed to a horrible death, consequently any operative procedure is justifiable. By so reasoning

TABLE III.— Cases of Cancer of the Uterus seen from May, 1912, to May, 1916.

Cancer of the cervix	107
Cancer of fundus	17
	124
Inoperable cases or refused operation	31
Radical abdominal operation	8
Panhysterectomy for cancer of fundus	14
Cautery — opening abdomen	32
Cautery — without opening abdomen	39
Total	124

TABLE IV.— End-Results of the Radical Abdominal Operation — 51 Cases of Cancer of the Cervix and Fundus operated upon at least five years ago.

Number of cases	51
Primary deaths	10
Number surviving	41
Number of recurrences	12
Died of intercurrent disease	2
Patients alive and well five years or more after operation	27
Percentage of permanent cures of all cases operated upon (Wertheim's formula)	56.2%
Percentage of permanent cures of those surviving the operation (Wertheim's formula)	69.2%

he is not respecting the rights of the patient whose wishes, not the surgeon's, should be paramount.

OPERABILITY

I am in no position to speak regarding operability of the cancer cases seen by me since May 1912, since I have been trying out the various methods of cauterization and have not used the radical operation for cancer of the fundus when it could have been employed. During the past four years I have seen in my university and private clinics 124 cases of cancer of the uterus, 107 cases of cancer of the cervix, and 17 cases of cancer of the fundus (Table III).

Unquestionably some of the cancer of the cervix cases could have been subjected to the radical operation, just how many I am unable to say, but I was anxious to give the cautery treatment a fair trial not only in the so-called inoperable cases, far advanced cases, but those in the doubtful class as regards choice of operation. Again, 31 patients were so far advanced that nothing could be done or else they refused operation.

I was not fortunate in my selection of cases for the radical operation as shown by my results, and the discouragement that followed undoubtedly influenced me in the choice of cautery methods. However, my experience with the cautery has not convinced me that it is in the slightest degree curative. On the contrary, I believe that the method must be reserved for those cases of cancer of the uterus where palliative measures only are indicated or where it may be serviceable in preparing a cancerous cervix for radical removal.

I have already spoken of my experience with panhysterectomy for fundus carcinoma and my determination to employ the radical operation in the future for this class of cases.

With the exception of these comparatively few cases where the radical operation might have been or was employed, the very large proportion of the cases of uterine cancer were inoperable from the standpoint of a possible cure. They were far advanced cases, even more, if I am any judge, than the previous 125 cases which came under my observation. This is not very encouraging so far as the results of our campaign against cancer are concerned, but it furnishes convincing proof of the need of such a propaganda.

END-RESULTS

I am able at this time to report the end-results of 41 cases of cancer of the cervix and fundus since the patients have all been operated upon five years. I am aware that percentages based upon such a small number of cases have only a relative value when compared with percentages of other operators based upon a large number of cases. As a matter of fact, however, we must employ the percentage method, if we are to compare results both large and small. Still it is best to keep in mind that percentages, favorable or unfavorable, in a small series of cases do not tell the whole story.

In Table IV been have recorded the end-results in 51 cases of cancer of the cervix and fundus combined, since the radical operation was performed for both classes of cancer. Naturally the end-results will be better than when cancer of the cervix is considered alone, since there is less tendency for carcinoma situated in the fundus to recur. I might again emphasize the point that this is true if the radical operation has been employed, the

TABLE V.— End-Results of the Radical Abdominal Operation for Cancer of the Cervix — 40 Cases operated upon at least five years ago.

Number of cases of cancer of the cervix	40
Primary deaths	9
Percentage of primary mortality	22.5
Number of patients with recurrences	11
Percentage of recurrences	36.4
Number dying of intercurrent disease	2
Number of patients alive and well at least five years after operation	18
Permanent cure of all patients operated upon by radical method (Wertheim's formula)	47.3%
Permanent cure of patients surviving the operation (Wertheim's formula)	62.0%

reverse being the case if ordinary panhysterectomy has been done.

In the 41 patients surviving the radical operation there were 12 recurrences, two died of intercurrent diseases, one tuberculosis and the other heart disease. There were 27 patients alive and well five years or more after the radical abdominal operation.

In order that there be no misunderstanding regarding the method of arriving at end-results in this and the other tables, it may be well to state that every patient was located and her condition ascertained for this report. In other words, just because a patient with cancer of the uterus operated upon radically had passed the five-year limit at the last report four years ago, it was not assumed she was well today. Her condition was ascertained by a letter from the patient herself or from her physician. Fortunately I am in a position to keep track of these cancer cases and have been able to secure the post-operative history of each patient.

Wertheim's rules for working out the statistics of the end-results for cancer patients subjected to the radical operation have been followed in the tables, because they are the simplest. All patients who die from intercurrent disease or who are lost track of must be subtracted from the total number of operations to ascertain the percentage of permanent cures in all cases operated upon. To obtain the percentage of permanent cures of those surviving the operation, the number of patients living five years or more after the operation must be divided by those surviving the primary operations after deducting those dying of intercurrent diseases and the number lost track of.

TABLE VI.— End-Results of the Radical Abdominal Operation for Cancer of the Fundus, 11 Cases operated upon at least five years ago.

Number of cases of cancer of the fundus	11
Primary deaths	1
Percentage of primary mortality	11.1
Number of patients with recurrences	1
Percentage of recurrences	9.8
Number of patients alive and well at least five years after operation	9

The end-results as shown in Table IV are surprisingly good and very encouraging. Five years or more after the operations, 56.2 per cent of patients operated upon for cancer of the cervix and fundus are permanently cured, while 69.2 per cent of those surviving the operations are well with no recurrence.

In order to forestall objections that the results were due to the inclusion of fundus with cancer of the cervix cases, the latter to the number of 40, the total number operated upon five years or more ago, have been arranged in Table V. The greatest interest centers around the number of patients alive and well after five years (18). Thus 47.3 per cent of the total number of patients with cancer of the cervix subjected to the radical abdominal method remain cured after five or more years, while 62.0 per cent of those surviving the operation remain cured.

But better than percentages, better than anything else is the knowledge that 18 women out of 40 subjected to the radical operation for cancer of the cervix may be pronounced cured, since they have passed the five-year period without a recurrence. This compensates in part for a high primary mortality since very few if any of these women would be alive today had other methods of cure been attempted.

There have been no further recurrences in the 11 patients with cancer of the fundus mentioned in the last report, Table VI. Of these one died from the operation and one from a recurrence one year after the operation. The remaining 9 patients are alive and well from five to twelve years after the operations. It has been considered inadvisable to figure the percentage of cures in such a small series of cases.

The time elapsed since the radical operations has been recorded in Table VII. Six patients have gone five years, five patients six

TABLE VII.— Patients alive at Present Time without Recurrence.

Length of time since operation	Cervix	Fundus	Total
13 years	1	0	1
12 years	1	1	2
11 years	0	1	1
9 years	1	1	2
8 years	2	1	3
7 years	6	1	7
6 years	5	0	5
5 years	2	4	6
3 years	1	0	1
1 year	1	0	1
			29

Number of cases five or more years after operation 29
Number of cases less than five years after operation . . . 2

years, seven patients seven years, three patients eight years, two nine years, two twelve years, and one patient eleven and thirteen years respectively. While it is impossible to state positively there will be no further recurrences in this series of patients who have passed the five-year limit, we have every reason to believe that such will be the case in most instances. However, it is interesting to note that one of the recurrences and deaths occurred in a patient who had been apparently free from the disease for five and a half years after the radical operation for cancer of the cervix.

It may be stated that the patient mentioned in the last report as having had a recurrence in the vaginal cicatrix five months after the operation with no recurrence for two years subsequently died of the disease.

SUMMARY AND CONCLUSIONS

1. Further experience with the radical abdominal operation for cancer of the uterus confirms the belief that it is an exceedingly dangerous procedure and will always be attended by a high primary mortality.

2. Even if the percentage of operability of cases of cancer of the uterus markedly increases in this country and elsewhere there will always be border line cases attended by a high primary mortality.

3. This is true because it is not always possible even with the greatest care in examination of the patient prior to operation to estimate the extent of the disease.

4. Errors in judgment mean death from shock if the disease be too far advanced or failure to complete the radical removal of the cancerous uterus.

5. However, in spite of a high primary mortality it is the only procedure with the possible exception of the extended vaginal operation which holds out any reasonable promise of a permanent cure.

6. Primary and end-results of the radical operation for cancer of the uterus must be considered together in order to judge of the good accomplished in a given series of cases.

7. Unless the operations be radical the end-results will be poor and if they be radical the primary mortality must be high.

8. If the end-results be poor the burden of proof is upon the radical abdominal operator to show why he did not choose a much safer palliative procedure.

9. Since 1912 experience with 14 ordinary panhysterectomies for cancer of the fundus shows worse primary and end-results than in 11 cases previously reported where radical removal was performed.

10. This showing and the results following removal of carcinoma of the fundus by various methods in the Wertheim clinic as reported by Weibel lead to the conclusion that, because carcinoma of the fundus is more easily cured than when the cervix is involved, we are not justified in thinking it can be treated any less radically than carcinoma of the cervix.

11. The primary mortality in 59 cases of cancer of the cervix and fundus treated by the radical abdominal operation was 25.4 per cent.

12. The extent of the involvement in cancer of the uterus can only be determined definitely after the abdomen has been opened. If the parametria are not too much involved and the condition of the patient's kidneys, heart, and blood-vessels warrant a prolonged and depressing operation it is justifiable to attempt the radical operation.

13. During the past four years 124 cases of cancer of the uterus have been seen in the university and private clinics. The disease was so far advanced in 36 cases that operation was refused or nothing was done. The cautery

method was tried in 58 cases and proved valueless except as a palliative procedure.

14. In spite of attempts to educate the public regarding cancer, the cases of cancer of the uterus seen during the past four years were more advanced than has formerly been the case.

15. The end-results in 51 patients operated upon five or more years ago were most gratifying, combining fundus and cervix cases; 27 of the 51 patients were alive and well after five years or 56.2 per cent of all cases operated upon, while 69.2 per cent of all those surviving the operations were alive after five years.

16. Of 40 cases of cancer of the cervix operated upon five years or more ago, 18 of those surviving the operation are alive and well today. Thus 47.3 per cent of the total number remain cured after five years while 62 per cent of those surviving the operation remain cured.

17. These percentages were obtained by Wertheim's formula where patients dying of intercurrent disease or those lost track of are subtracted from the total number of operative cases or from the number surviving.

18. The length of time elapsed since the operations upon the 18 patients who are alive and well vary from five up to thirteen years. There is every reason to think these patients are permanently cured although one patient did have a recurrence and died between five and six years after the radical operation.

19. In spite of the high primary mortality the end-results in those surviving the operation encourage us to continue with the procedure in suitable cases.

X–RAY TREATMENT OF UTERINE HÆMORRHAGE[1]

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INTRODUCTORY

THE X-ray has been employed in gynecology for a sufficient length of time to allow the profession to form an accurate idea of the merits and demerits of this method of treatment. Nevertheless the conclusions arrived at vary greatly. Some authors, particularly those of the Freiburg school, and many roentgen therapeutists laud the X-ray highly; others, especially certain gynecologists, view the entire question of X-ray therapy with suspicion and are inclined to class the method with the numerous transitory fads so common in contemporary medicine.

The present paper aims to defend X-ray therapy from its friends. Properly employed, in properly selected cases, the treatment is invaluable and indispensable in gynecology; used promiscuously by the uninitiated, roentgenization is as dangerous as the surgeon's scalpel in the hands of the ignorant and the meddlesome.

The writer has used the X-ray for a number of years. He has never given the exposures himself, but has always referred the patients to the same roentgenologist. The selection of cases, the general directions (i.e., the effect to be attained, such as the toning down of bleeding, amenorrhœa, etc.), the control of physical findings have remained in the writer's hands, while technical questions have been left entirely to the judgment of the X-ray specialist. No attempt to discuss the minutiæ of technique will be made in this paper. Such information is readily accessible (1). Burns or other serious disturbances are practically unknown today, if treatment is entrusted to competent hands.

MODUS OPERANDI OF THE RAYS

The X-rays affect uterine hæmorrhage indirectly by their influence upon the ovaries (2); there is also a certain amount of evidence that uterine fibromyomata are influenced directly (3).

[1] Read at the meeting of the American Gynecological Society, Washington, May, 1916.

Ripe and partly ripening follicles are very susceptible to the rays. Primordial follicles, on the other hand, are extremely resistant even to massive and prolonged exposure, the ovaries of young women proving more resistant than those of older females. Whether this increased resistance is due purely to the greater number of primordial follicles in the young is not known.

As the menstrual function is dependent upon ovulation and the subsequent development of the corpus luteum (4), such uterine hæmorrhages as result from normal or abnormal ovarian influences are necessarily affected by the inhibition of follicle ripening and ovulation. If all ova are destroyed, permanent amenorrhœa results; if all ripe and ripening follicles are killed, menstruation ceases, until some primordial follicles have had time to ripen and to rupture. Moreover, considerable clinical evidence obtains that certain qualitative changes arise from roentgenization and persist after cessation of treatment, such as permanent diminution of menstrual bleeding. The physiological changes, at the basis of this phenomenon are unknown.

Certain observation showing increase of connective tissue in fibromyomata which were subjected to raying, have been interpreted as direct X-ray effects (*loc. cit*). Quite possibly, however, the fibrosis is an involution effect due to the withdrawal of ovarian stimuli from the tumors, comparable, though not identical, with the shrinkage of fibroids, usually noted at the physiological menopause.

TECHNICAL

Fractional treatment implies exposure to the rays for 4 to 6 minutes of one or more large fields in the lower abdomen, two to three times weekly over long periods of time. Such graduated dosage, though slow of effect, usually permits of accurate control of the degree of influence exerted upon the ovaries. It is, therefore, especially recommended for cases where reduction of bleeding and not amenorrhœa is desired.

Intensive treatment, according to the improved Freiburg technique permits of the use of enormous doses at each sitting (small multiple fields, filtration, cross fire, and lately also the Coolidge tube). By this means amenorrhœa may be achieved within a short period of treatment (9 to 18 weeks). This form of treatment is applicable to cases in which profuse bleeding must be controlled within a short period of time. Graduated effects are less readily obtained.

It is at times indicated to give one or two intensive treatments, to obtain control of the bleeding, and then to continue with fractional doses, in order not to produce amenorrhœa. An experienced technician can thus produce the desired effects almost at will.

APPLICABILITY

X-ray therapy is applicable in:

1. Functional menorrhagia and metrorrhagia of adolescents.
2. Functional menorrhagia and metrorrhagia during sexual maturity.
3. Functional menorrhagia and metrorrhagia preceding the climacterium.
4. Menorrhagia and metrorrhagia due to fibromyomata.

1. *Adolescent hæmorrhages.* Prolonged and irregular hæmorrhages between the ages of 13 and 18 years are not uncommon. The majority of cases respond to general tonic treatment, uterine styptics (ergot, styptol), and hygienic measures. A small number require one or more curettages. A still smaller number, in whom the preceding measures fail to cure, are relieved by serum injections, calcium chloride by mouth or rectum, or transfusion. The few remaining cases, usually quite desperate, because of their extreme anæmia and debility, after all measures have been tried in vain, are saved from hysterectomy or oophorectomy by X-ray treatment. One or two intensive treatments are followed by fractional exposures until complete amenorrhœa is obtained. This effect is usually not attained for several months during which the bleeding occurs less and less frequently and in diminishing quantities. If vasomotor symptoms (flushes) develop, the exposures should at once be diminished, as the dosage has been sufficient to produce amenorrhœa within a short time.

The amenorrhœa may persist for 8 to 12

months; then scant and irregular (every 3 to 6 months) periods appear; finally normal menstruation is re-established. Permanent amenorrhœa is almost impossible to obtain in very young women.

2. *Functional menorrhagia and metrorrhagia during sexual maturity.* Occasionally cases are encountered in which purely functional hæmorrhages necessitate interference. The patients usually are in the early thirties, and have had one or more children. The bleeding may take the form of either menorrhagia or metrorrhagia, or both. Inflammation can be excluded both by the history (absence of venereal infection, normal puerperiums, etc.) and by the physical findings. Usually the sole change noted is a moderate symmetrical increase in size of the entire uterus. Repeated curettages either produce only temporary palliation or are of no avail. The curettings regularly show "endometrial hyperplasia" or "cystic endometrial changes." Formerly such cases, after palliative measures had failed, were treated by atmocausis or hysterectomy. Some of these patients desire more offsprings.

When the condition is clear — i.e., absence of inflammatory lesions, curettings showing absence of carcinoma — X-ray treatment is applicable. If no more children are wanted, amenorrhœa may be induced; otherwise the bleeding should be "toned down" by fractional dosage; the more advanced the age of the patient the less exposures are needed. When the periods occur only at 2 to 4 months intervals and are scanty, it is well to temporarily stop treatment, in order not to run the risk of producing the menopause. Such patients may later conceive and bear healthy children.

3. *Functional preclimacteric menorrhagia and metrorrhagia.* In these cases carcinoma must always be excluded by one or more curettages (microscopical control). The curettings ordinarily resemble those obtained in Class 2. Unless the adnexal regions are free, X-raying is also contra-indicated. Many of the cases clinically fall into the group of so-called "fibrosis uteri," "myopathies," "metritis" etc.

Other things being equal the patient should be given the choice between operation and X-ray. In cases in which vaginal hysterectomy promises to prove technically easy, operation should be preferred; on the other-hand, in obese, emphysematous patients, or those appearing to be poor operative risks, roentgen treatment is to be recommended as less dangerous than operation.

A few intensive treatments regularly produce permanent amenorrhœa. If this outcome is not obtained, a mistake in diagnosis has been made (carcinoma, pedunculated submucous fibroid).

4. *Menorrhagia and metrorrhagia due to fibromyomata.* This class of cases has given rise to the largest amount of discussion. Kroenig and Gauss (6) claimed 100 per cent cures, where the method was used, and an applicability of 85 per cent. The writer, on the other hand, finds an applicability of only 5 per cent in his material (7). Between these widely divergent views, all manner of opinions are noted.

To form a correct opinion, a number of factors must be taken into consideration. The discovery of a symptomless fibroid *per se* does not indicate any interference. In the writer's experience only 45 per cent of fibroids require treatment, especially if the patient is not informed of the presence of a "tumor." Some member of the family may be made aware of the condition, in order to safeguard the physician. Unless fibroids produce menorrhagia and metrorrhagia, pressure symptoms or enlargement of the abdomen, their presence is rarely noted and operation not considered.

Bleeding is the symptom most often complained of, and most readily relieved by raying. Before X-ray treatment can be considered, carcinoma must be excluded by exploratory curettage. The absence of cancer can be demonstrated only if the entire endometrial cavity is accessible to the curette. Uteri which contain tortuous cavities (submucous fibroids) ought, therefore, not be rayed.

Where pressure symptoms are severe, or where large tumors are noted, the writer excludes the use of the rays, because several months of treatment must elapse before con-

siderable reduction in size of the mass and consequent relief can be looked for.

Kroenig and Gauss consider the following conditions as contra-indicating X-ray treatment:

1. Pedunculated submucous fibroid partly extruded from the cervix.
2. Gangrenous or suppurating fibroids.
3. Combination of fibroid and endometrial carcinoma.
4. Fibroids in which rapid growth, profuse metrorrhagia, and unsuccessful roentgen treatment makes the fear of sarcomatous degeneration likely.
5. Fibroids causing acute incarceration of the bladder.

Besides this they rarely recommend radiotherapy for patients below the age of 35 years, as permanent amenorrhœa is difficult to obtain.

These contra-indications are not sufficiently rigid. Abdominal diagnosis, including gynecological diagnosis, is notoriously uncertain. Surprises are constantly encountered. Even the experienced clinician will occasionally "slip up" on an apparently simple diagnosis, mistaking, for instance, a cyst for a fibroid. In order to protect the patient, it is necessary to exclude all doubtful and complicated cases. What constitutes a doubtful or a complicated case remains a matter for the judgment and experience of the gynecologist to decide. The writer in a series of 419 unselected cases, which were admitted for operation to Dr. Brettauer's service at Mt. Sinai Hospital, found 140 complicated cases (35 per cent) as the Table I will show.

Of the 140 cases, at least 74 (18.5 per cent) presented conditions absolutely contra-indicating raying. Many of these conditions were not and could never be diagnosticated before operation.

Absolute contra-indication to X-ray treatments in the writer's opinion is present, if carcinoma or sarcoma are found or suspected; if ovarian cysts or tumors are felt, if the uterine tumor is rapidly growing, if the tumor is large (size of a 5 to 6 months' pregnancy), if the palpatory findings are doubtful (suspicions of adnexal trouble, of rectal or sigmoid tumor, of adhesions, etc).

TABLE I

Malignancy		15
Carcinoma		
Of uterus	2	
Of gut	1	
Sarcoma		
Of uterus	5	
Of mesentery	1	
Ovarian papillomatous cysts	6	
Proliferating ovarian growths (non-malignant)		18
Dermoid cysts	3	
Non-malignant cysts	15	
Adnexal diseases (serious)		13
Tubo-ovarian abscess	4	
Tubercular salpingitis	3	
Pyosalpinx	6	
Uterine Conditions		13
Necrotic and gangrenous fibroids (hysterectomy)	5	
Necrotic and gangrenous fibroids (myomectomy)	7	
Tubercular endometritis	1	
Pregnancy		15
Hysterectomy necessary	9	
Myomectomy necessary	2*	
Curettage	2	
Exploratory	2*	
Not operated on	4*	
Complications absolutely contra-indicating rays		74
Less serious complications		
Hydrosalpinx	7	
Chronic diseased adnexa	52	
Cystic ovaries	34	
Complications not absolutely contra-indicating rays		66
Total complications		140 (35.00 per cent)
Contra-indication to rays		74 (18,50 per cent)

*Gravidity continued

Pedunculated or degenerating tumors, when recognizable, are also contra-indications. Urgent symptoms will necessarily preclude the use of the rays.

In clear cases of uncomplicated fibromyomata not excessive in size, but causing symptoms, the question of raying versus operation may be considered. The decision rests with the patient, who should be enlightened in regard to the risk of operation (mortality 0.5 to 2 per cent)[1] on the one hand, contrasted with the duration and expense of X-ray treatment on the other.

SOCIAL CONSIDERATIONS

X-ray treatment can be given to the impecunious only in well equipped and well endowed institutions. In addition to the initial expense of the installation, the operator's time, the electricity consumed, and the replacement of tubes, etc., produce a formidable expense account. Fractional exposures (4 to 6 minutes) cost approximately $3.00 each to cover expenses, and may have to be continued 2 to 3 times a week for many months. Intensive exposure, sufficient to produce amenorrhœa and shrinkage of a fibroid in a

[1] In 400 operations, 7 patients died. In 4 of these the rays could not have been used (sarcoma of uterus and papilloma of ovary, fibroid and pregnancy with Basedow, necrotic fibroid extruding from cervix, sepsis, fibroid incarcerating bladder, vesical resection.

woman over 35 years of age, will cost from one hundred to three hundred dollars at a minimum.

INDICATIONS

Taking into consideration the absolute contra-indications, the danger of operation, the expense and time involved, the writer believes that about 5 per cent of fibroids (i.e., 10 per cent of those requiring interference) should be treated with the X-ray. These indications are met in uncomplicated cases in which (1) operation is declined; in which (2) operation is contra-indicated because of extreme nervousness or psychical unrest, in which (3) operation is inadvisable because of serious heart disease, renal, or pulmonary lesions.

SUMMARY

1. The roentgen ray produces amenorrhœa by destroying the ovarian follicular apparatus, or oligorrhœa by partial destruction of follicles. The resulting menopause symptoms correspond in character and degree to those of the post-operative menopause.

2. The choice lies between two methods of application: (a) the fractional weak, requiring prolonged use, but readily controllable; (b) the intensive-massive, more rapidly producing amenorrhœa.

3. Obstinate cases of hæmorrhage in adolescents can be cured. Only such cases as have resisted all other forms of therapy, should be selected.

4. Functional hæmorrhages during sexual maturity, if conditions are unmistakable, and curettage shows absence of carcinoma, may be relieved by producing oligorrhœa (with the possibility of subsequent pregnancy) or definitely cured by inducing the artificial menopause.

5. Preclimacteric functional hæmorrhages are readily cured by the production of the menopause. At this age, malignancy must be even more carefully guarded against.

6. Uterine fibroids may be slowly reduced by X-ray treatment. All complicated cases should be excluded, as otherwise serious or fatal mistakes may occur. In properly selected cases (5 to 10 per cent) the choice between operation and roentgen therapy may be left to the patient. In patients with serious heart lesions, nephritis or pulmonary trouble, or in the hyperneurotic, preference should be given to the X-rays.

CONCLUSIONS

X-ray in gynecology has proved an invaluable addition to our armamentarium. It enables the gynecologist to exert graded effects upon the ovary, and thus control the menstrual cycle in degrees varying from slight inhibition to permanent destruction of function. It also causes fibroid tumors to diminish in size or to disappear.

The main danger to be apprehended in X-ray treatment is their application by error to malignant tumors. Such danger is minimized by excluding cases which present doubtful or complicated findings. Hence the treatment must always be controlled by the trained gynecologist, because diagnostic accuracy is far more essential than if operative measures are contemplated.

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PRECANCEROUS CHANGES IN THE UTERUS[1]

By WILLIAM S. STONE, M.D., New York

THE failure of scientific medicine to discover either a cause or a cure for cancer does not deny an assurance of a promising field in a more definite investigation of the local physiological and pathological changes which relate to the inception of the disease in individual organs.

Numerous conditions are recognized clinically as preceding or associated with cancer of the uterus in a variable percentage of cases. Trauma of the cervix during parturition, resulting in a variable amount of ectropion, is generally regarded as an important factor in the etiology of cancer of the uterine neck, but its histogenetic significance — whether related to the presence of scar tissue, to regenerative hypertrophy, or in furnishing a larger field for atypical strife between two kinds of epithelium — is far from established. Chronic inflammatory diseases are becoming more definitely recognized as antecedents of neoplastic growth in the uterus, as well as in the breast and other organs.

Polese (1), for example, states that an endocervicitis preceded cancer of the cervix in 34 of his 48 cases, and we find in the records of numerous observers how often such changes are related to the history of gonorrhœa, less often to that of tuberculosis. Syphilis is more definitely related to the inception of a cancerous disease in some regions of the body than any other common disease. In the uterus its relation is less well defined, but with our present resources in diagnosis a promising field for pathological research appears to be furnished in a closer study of those lesions designated as leucoplacia. Ewing (2) states that the cervical erosion is the most definitely established lesion known to precede cervical cancer, and for corpus carcinoma, he says, the chief definite etiological factor is the association with myoma. Evidence of this frequent association of myoma with cancer of the uterus is furnished by numerous writers. Taussig (3) states that in a personal communication from the Mayo Clinic he learned that myomata were present in 10 out of 40 cases of cancer of the corpus uteri in that clinic.

The observation of such causal relations, however important they may be in the study of the occurrence of uterine cancer, does not include its formal histogenesis, the study of which becomes necessary in order to define the term "precancerous."

Clinicians are generally agreed that there are no pathognomonic symptoms of uterine cancer until the tumor growth has become well established, and usually not until its destructive capacity is grossly manifested. Atypical bleeding or discharge, combined with other symptoms and a careful physical examination, can only create a weak or strong suspicion of its early existence without the aid of a competent histological examination, from which it is universally expected that a positive confirmation or denial of the clinical suspicions will be made. Failure to receive a positive diagnosis often creates in the mind of the clinician a suspicion of the incompetency of the pathologist, or in the mind of the pathologist that he has not been furnished with the proper material. Each of these conditions may maintain, but an analysis of the histological criteria upon which a positive diagnosis of a fully established cancerous growth is made shows that the pathologist, like the clinician, is ordinarily not prepared to make such a diagnosis until some amount of destructive capacity is histologically manifested. In other words, cancer is an evolutionary process, requiring time to show its actively destructive purpose. Ewing (2) says, "It is not true that a pathological condition must be either cancer or not cancer. It may be neither the one nor the other. It may be in the process of becoming cancer." Using this author's analysis of the histological criteria in the diagnosis of cancer, we have: "(1) Cellular overgrowth passing beyond that observed in other processes affecting the same tissue; (2) atypical qualities of the cells, metaplasia, anaplasia; (3) loss of

[1] Read before the American Gynecological Society, Washington, May 10, 1916.

polarity; (4) heterotopia; (5) desmoplastic properties; (6) local invasive properties; (7) metastases." Before there is an appreciable amount of heterotopia or invasive features, however, innumerable combinations of criteria may be seen, each varying in quantity and quality. In some cases the amount of proliferation will make a striking feature; in others the atypical quality of the cells — their size, irregular shape, peculiar staining qualities, especially the larger size and hyperchromatism of their nuclei, or their loss of polarity — will present such pictures that one feels reasonably certain that a malignant growth is in a developing stage. To many of such areas the term "precancerous" seems to be appropriately applied.

In the literature of uterine cancer we find much to support the idea that the evolution of a malignant growth can be observed from its beginning in definitely benign lesions to a stage in which it becomes a fully developed neoplasm. Schottlaender and Kermauner (4), in their extensive monograph, express the evolutionary character of cancer in the use of the terms, immature, moderately mature and fully mature, according to the number and kind of morphological features that they present, without regard to their histological type, size, or age. Contrary to the opinion of the majority of pathologists they believe that, although there is no specific criterion by which the earliest beginnings of cancer-cells can be recognized, it is possible to recognize an immature stage of cancer before its destructive growth is shown, especially in the squamous cell form, most of which appear in this stage. To those cases in which the morphology appears doubtful they use the term "precancerous." While other writers are not so frank in the use of this term, there is much evidence in their discussion of atypical changes of benign lesions in the uterus and their relation to the development of malignant growths to justify its application to a definite variety of intermediary changes.

Metaplasia. The transformation of cylindrical epithelium into the stratified variety has been produced experimentally in the stomach of lower animals by Fuetterer (5) and Possner (6), and metaplasia of epithelium in the gall-bladder, stomach, urethra and other organs has become established as a definite factor in the development of squamous-cell carcinoma in these organs. The uterus offers an especially fertile field for the study of the significance of this change in the evolution of malignant neoplasms. A certain amount of epithelial change and proliferation is shown by Klein (7), Mueller (8), and others to occur as a result of the physiological functions of menstruation and pregnancy, and the factor of atrophic changes of the surface epithelium after the climacteric in the production of epidermization is discussed by Moericke (9). R. Meyer (10), in finding islands of stratified epithelium in the surface epithelium of the uterine body of a newborn infant, and in subsequent observations, has contributed much to the factor of developmental error. Friedlaender (11) observed small islands of stratified epithelium both on the surface and dipping in a few places into the glands of the lower segment of the uterine body of a child of five, which he ascribed to hæmorrhagic effusions and exfoliation of particles of mucosa during a severe scarlatinal nephritis. The potential frequency of metaplastic change in the uterine mucosa is discussed by Werth (12) in the regenerative changes following curettage. Its frequency, as presented by Zeller (13), in every form of chronic endometritis is questioned by subsequent writers, but its occurrence in long existing chronic inflammation, due to gonorrhœa, tuberculosis and, perhaps, to syphilis, is amply attested by numerous observers — Gebhard (14), von Franque (15), Ruge (16), Hengge (17), Oeri (18), Kaufmann (19), Sitzenfrey (20), Schauenstein (21). Hitschmann (22), for an explanation of this process in the uterus, offers the view that under pathological conditions the uterine epithelium may acquire the old embryonic capacity of that of the mueller duct to form indifferently either cylindrical or stratified squamous epithelium in any part of its course, and believes that, exclusive of polypi and other benign tumors, its presence in the form of a true epidermization does not occur except as a malignant process. As a

histological criterion in the diagnosis of neoplastic changes its importance is related to its diversity of form and extent in those lesions under discussion.

Cervical erosion. The strongest argument against the histogenesis of carcinoma from this lesion has been the apparent infrequency which cancer has been observed clinically to follow such a common lesion. The best clinical record of such a sequence is that of Beckmann (23), who, in a case, 37 years of age, that he had treated for an erosion over a period of five years, finally saw a squamous cells carcinoma develop. In another, 43 years of age, after two years duration of a lesion diagnosed as ectropion, an excision was made, one and one-half years after which a carcinoma appeared. Several factors suggest themselves as contributing to the infrequency of such observations: (1) The failure of the patient to consult a competent clinician before the tumor is well established; (2) the length of time that such benign lesions probably exist before atypical changes begin preclude the continuous observation by a single clinician; (3) the frequent cure of such lesions by minor surgical procedures; (4) the orthodox conception of the pathologist that no intermediary stages can be recognized morphologically between benign and neoplastic change. The evidence, however, in pathological literature has become sufficient to direct our attention to a closer study of the atypical changes which frequently occur in the course of healing of cervical erosions. Ruge and Veit (16) long ago expressed the opinion that erosions are not always a simple and unimportant process, and that an isolated erosion gland cannot always be differentiated from an isolated carcinoma gland without the surrounding tissues. Amann (24) refers to a number of cases in which the newly formed epithelium in a healing erosion spreads like a portio epithelioma. Winter (25) states that a true portio epithelioma not rarely forms from a healing erosion. Koblanck (26) can only express the differential character of a healing erosion and a portio carcinoma in the greater or less amount and regularity of epithelial metaplasia, and the more or less atypical qualities of the cells. Alfieri (27) has traced a carcinoma of the vaginal vault to a follicular erosion gland in a case of endocervicitis. Von Franque (15), in a case 43 years of age, found typical carcinomatous epithelium in the glands of a follicular erosion which he regarded as suspicious. Rubin (28) has recorded three cases of undoubted incipient cancer arising in a definite proliferation of atypical epithelium on the surface and in the glands of healing erosions, in which the diagnosis was made: (1) from indistinct definition of cell outline, especially in the deeper layers; (2) from the irregular, large, hyperchromatic nuclei, occasionally lumped together; (3) no definite stratification of the layers and lack of alignment of the basal cells; (4) marked nuclear granulation, as seen frequently in carcinoma in which hornification has not appeared. Mitoses and hornification, he regards, as variable qualities. Schauenstein (21) gives a comprehensive description of the evolutionary features of cancer of the cervix in a report of four cases. His first case, presenting an atypical proliferation of epithelium cells in a circumscribed area of the portio and along the lower part of the cervical canal, differed quantitively from a healing erosion in the amount of cell proliferation along the surface and the extent to which the glands were filled with stratified epithelium, and, qualitively, in the atypical character of the cells, in their loss of polarity in the deeper layers, and the presence of numerous atypical mitoses. The other three cases, which appear to be definitely established carcinomata, differed from the first case in the amount of their atypical qualities and in the distinct heterotopia and slight stroma invasion. No macroscopic growth was found in any of the cases, but in the three fully established growths it extended superficially along the entire cervical canal in one, to the lower part of the corpus mucosa in another, and to the corpus and vaginal wall in the third, the vaginal epithelium being preserved over the growth. The morphology of the cells in the first case differed slightly more from those seen in atypical healing erosions than it did from the other three cases, the latter differing from

each other chiefly in the amount of definition of cell outline. Under a high power the differentiation between the cells of the first and other cases, he says, could not be made. Schottlaender and Kermauner (4) made a similar observation regarding the differential morphology of such cases. In other words, Schauenstein made the diagnosis of a definitely established cancer in three of his cases by a destructive action, manifested by a distinct heterotopia and invasion of the glands not only by a direct proliferation through their mouths but also by bursting through their walls with which they came in contact. He believes that the first case was becoming a similar growth and only needed time to show its destructive action. K. Ulesko-Stroganowa (29), in a report of three cases, describes the histological features of developing carcinomata on the base of healing erosions, but her drawings do not confirm the descriptions, and the rapid regression of the processes that she was able to demonstrate by an examination of the uteri, which were removed four weeks later in two cases, and of the cervix which was amputated two weeks later in the other, makes it seem probable that in these cases there was only an exaggerated amount of cellular proliferation in the process of a healing erosion in two of the cases and a gonorrhœal infection in the other. They show, however, the evolutionary character of the process. Cullen (30), to whom we are much indebted for his analysis of the histological criteria in the diagnosis of uterine cancer, shows pictures of sections in the neighborhood of fully established tumors, which he regards, if taken by themselves, as suspicious.[1] If no other evidence of growth existed, how shall such changes be interpreted, except as representing the developing stage of cancer?

Leucoplacia. The potential elements in these lesions of the tongue to develop cancer has long been recognized. Weir (31), 1875, was the first to describe leucoplacia of the female genitalia in the report of two cases occurring upon the vulva, both of which developed cancer. Since then a few writers have described their occurrence on the vagina, portio, cervical and uterine canal, which in most instances after a long time, have developed into cancer. Von Franque (15) made the first clinical observation of leucoplacia of the portio developing into a carcinoma, observing the case as beginning in an erosion. His second case observed over a period of six years, finally became a carcinoma. Berkeley and Bonny (32) consider leucoplacia of the vulva as the first stage of cancer. Sweeney (33) reports a case, 33 years of age, giving a history of syphilis and a positive Wassermann. It was also associated with a gonorrhœal pyosalpinx. No improvement followed the use of salvarsan and six months later a hysterectomy was done. Nothing of importance has been written regarding the etiology of these lesions in this region or their relation to syphilis, except that in a few instances there has been a history of syphilis. So few cases of uterine leucoplacia have been recorded that it must be considered clinically a rare disease. It has appeared in the cases so far reported on the portio in association with similar and usually more extensive areas upon the vaginal walls, or extending along the cervical and uterine canal to the fundus. The lesion appears as yellowish white, slightly elevated patches of different sizes, discrete or joined to each other by narrow bridges. The patches are adherent to the underlying tissue, which bleeds if they are wiped away (von Franque, Sweeney). It has been described in a more extensive and diffuse form under the name of psoriasis or icthyosis by von Rosthorn (34), von Franque (15), Zeller (13), and others. Its pathology, as given by d'Hotman de Villiers and Thérèse (35), Jayle and Bender (36), von Rosthorn (34), and von Franque (15), consists of a marked metaplasia and thickening of the horny layer, with increase in the keratohyaline granules of the stratum granulosum (Sweeney, 33), resulting in complete epidermization, and often showing considerable epithelial downgrowth. The more extensive growths which have existed a long time may present the picture of an adult acanthoma, as, for example, the case of von Rosthorn (34), which is so regarded by Hitschmann (22) and others. This epidermization of the uterine mucosa relates specifically to the histogenesis of a

[1] Pages 57, 290, 293.

number of recorded cases of carcinoma, in which an extensive but superficial spread of the growth has occurred, covering a greater part of the mucosa of both the corpus and cervix—von Pierung (37), Ruge and Veit (16), Benckiser (38), Hofmeier (39), Gebhard (14), Gellhorn (40), Kaufmann (19), Schauenstein (21). Some of these cases have shown acanthoma in the corpus and adenoacanthoma in the cervix, or focal areas of acanthoma in an adenocarcinomatous structure, for which an explanation may be reasonably found in the pre-existence of leucoplacia. Pfannenstiel (41) says every case of epidermization is not suspicious, but it is a precancerous stage in the same way that glandular hypertrophy and hyperplasia is to adenoma and adenocarcinoma.

Uterine polypi. Numerous writers have directed attention to the frequency of sufficiently atypical epithelial metaplasia and overgrowth in uterine polypi—Klob (42), Billroth (43), Amann (24), Keitler (44), Winter (25), Kroemer (45), Bulius (46), Kuestner (47), Gessner (48)—to furnish evidence of their malignant tendency. Oeri's (18) description and drawings of the changes in both the surface and gland epithelium justify his conclusion that, although a diagnosis of a fully established neoplasm can not be made, they contain the potential elements of a developing cancer. He also reviews the literature of similar cases. J. Williams (49) describes a mucous polyp in which the downgrowth of epithelium into the glands is atypical enough to create the impression of a developing malignant growth. Opitz (50) directs attention to the frequency of epithelial metaplasia over that part of the polyp projecting into the vagina, in which he sees a base for the development of a malignant change.

Submucous fibromyomata. The importance of these tumors in the development of carcinoma, especially if they become pedunculated, relates primarily to the circulatory and nutritional changes they produce in the neighboring mucosa. We are indebted to Sitzenfrey (20) for a comprehensive description of the changes which occurred in two cases. In the first instance, the histology of the curettings in a case of necrotic submucous fibroid showed an immature epidermization and a slight papillary proliferation of the surface epithelium and mouths of the gland ducts. In one area the cells became more atypical and heterotopic, suggesting at two points a beginning invasion of the underlying stroma, from which he regarded the case as strongly suspicious of a malignant formation. The case remained well, however, during 4½ years of observation. In the other case, 50 years of age, a submucous fibroid had been removed six years previously. A curettage for bleeding and discharge revealed an extensive metaplastic growth of surface epithelium and deep invasion of the gland ducts. Because of her age, the presence of a necrotic polyp and other submucous myomata, a hysterectomy was performed. The uterine mucosa had a rigid, white opaque appearance, except near the insertion of a fibrous polyp where it appeared to be softer. Microscopically, the mucosa was generally epidermized from the upper part of the cervix to the fundus as a result of a long-existing pyometra. Two layers could be distinguished in most of the areas; a markedly hornified and a proliferating germinative, qualitively sufficiently atypical in a few areas both on the surface and in the glands to arouse suspicion of a malignant change, but for some time it was regarded as a benign epidermization. Subsequently, however, von Franque discovered in a section of the anterior wall an area in which the atypical character of the cells, the heterotopia and stroma invasion appeared to justify the diagnosis of carcinoma. In this area a figure is shown of atypical cell-growth bursting through the membrana propria at the fundus of a gland, while the epithelium nearer the mouth of the gland appeared normal. In this connection, Sitzenfrey's observation of another case, 28 years of age, is important. After a manual extraction of the placenta and a puerperal infection atypical bleeding occurred over a period of two years, during which three curettings were performed. The first curettings showed a very marked overgrowth of both surface and gland epithelium in association with the changes of a diffuse chronic endometritis, but there

Fig. 1. Papillary erosion. Chronic endocervicitis. Slight epithelial proliferation.

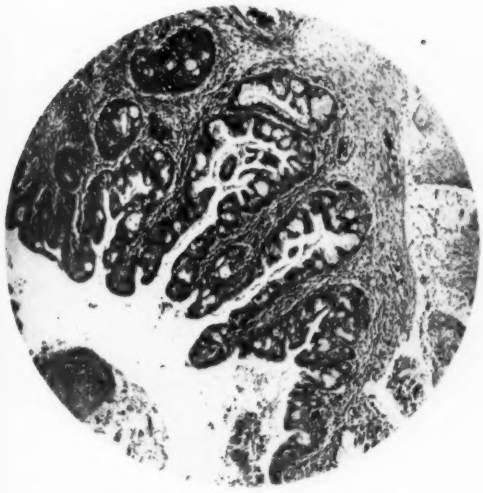

Fig. 2. Cervical polyp. Marked papillary overgrowth. Mucoid degeneration of cells.

were none of the features of a neoplasm. The subsequent curettings showed a marked regression of the process, in the last, only a few places presenting a slight stratification of both surface and gland epithelium. Similar changes of benign epidermization were observed by Hengge (17) in two cases, 44 and 49 years of age.

Glandular hypertrophy and hyperplasia. The glandular type of uterine cancer presents greater difficulties in the diagnosis of its incipient stage than the other forms, because the preservation of the normal gland type persists in so many instances until the amount of neoplastic structure has reached bulky proportions. The frequency also of advanced grades of gland hypertrophy and hyperplasia in menstruation, pregnancy, and chronic inflammatory conditions adds to the difficulty, making it at times quite insuperable. The claim of Gebhard (14) that a malignant adenoma arises by a gradual transition from the ordinary form of hypertrophy and hyperplasia is not supported by the majority of pathologists. Baecker (52), however, reports a case in which during a period of ten years the uterus was curetted 20 times. The first 18 examinations showed ordinary hyperplasia, the nineteenth a benign adenoma, and the last a definite malignant neoplasm. Schottlaender and Kermauner (4), in an analysis of the histological criteria of their cases, do not minimize the difficulties which the diagnosis of this type of growth presents in its inception, but in cases in which the change is limited even to the upper layers of the mucosa, in which the only destructive sign is that of the lessened amount of interglandular stroma, in which the eversions and inversions of the gland epithelium are atypically excessive, and in which the staining quality of the cells, especially of the nuclei, is altered, they offer a description which makes the diagnosis of a beginning neoplastic growth something more than a subjective feeling. Whenever minimal amounts of such morphological change occur in definitely focal areas of otherwise normal structure, especially if physiological and other pathological causes may be excluded, and when they occur at the age when malignant growth is most common, are we not justified in applying the term "precancerous"? Cullen has described the differential features of glandular carcinoma of the corpus uteri, and in a few of his cases illustrations and interpretations are given

Fig. 3. Epidermoid metaplasia in a cervical erosion. Pregnancy.

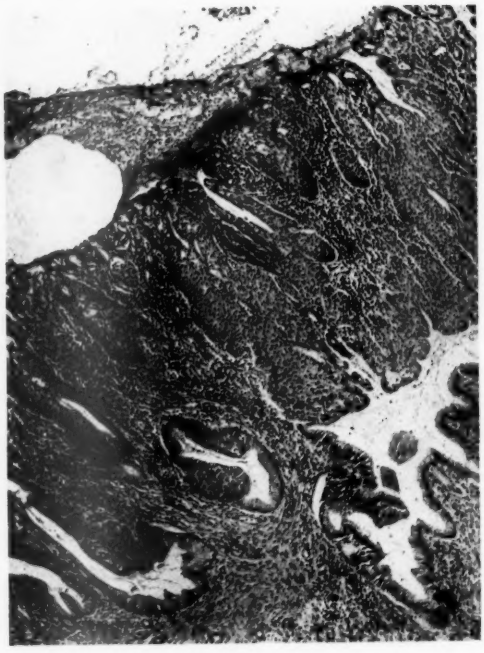

Fig. 4. Small mucous polyp. Excessive epidermoid metaplasia.

which seem pertinent to our subject.[1] Atypical proliferation of both surface and gland epithelium are seen which he defines to be suspicious, or probable areas of beginning carcinoma, the definite diagnosis, however, depending upon the presence of a macroscopic tumor, or the existence in other parts of a fully established growth. His case number 4598, page 527, appears to the writer to be very suggestive of a precancerous change. Two illustrations are given showing an atypical proliferation of epithelium, one on the surface and the other in a gland, which created enough suspicion of malignancy in the author's mind to request the patient to travel 300 miles for a second curetting. Nothing was found at the subsequent operation, performed three months after the first, and the patient's condition was reported to be well three years afterward. Cullen's conclusion from the sequence of events that the patient did not have a fully established growth is undoubtedly correct, but to the writer it seems reasonable to make an interpretation other than that such a proliferation was simply part of an acute endometritis. The argument that solid masses of cellular proliferation, such as are shown in one of the illustrations, are not characteristic of early adenocarcinoma of the uterus, is true, but from the literature which the writer has given it seems not at all unlikely that both the surface and intraglandular proliferation may express the presence of focal areas of metaplasia, perhaps in the process of becoming leucoplacia as a result of a gonorrhœa, of which the patient's history was said to be suspicious. If so, the case may be reasonably considered precancerous.

As an additional contribution to the literature of the subject of precancerous change the writer offers the following cases which he has collected from the uterine material in the Pathological Laboratory of the Cornell University Medical College:

[1] Pages 323, 444, 526, 527.

Fig. 5. Cervical polyp. Extensive papillary and epidermoid proliferation.

Fig. 6. Papillary endocervicitis. Miniature island of epidermization.

CASE 1. Papillary erosion. Chronic endocervicitis. Slight epithelial proliferation (Fig. 1).

Slide submitted to the laboratory for diagnosis. The stroma shows an advanced chronic interstitial inflammation. There are numerous dilated follicles projecting into the area of the mucosa, which is thrown into papillary tufts, covered in the recesses by normal cylindrical epithelium, but largely devoid of epithelium on the tops. One or two places, however, give evidence of epithelial proliferation into several layers. There are numerous sections of glands within the stroma of the tufts, but there is insufficient evidence to make the diagnosis of a beginning neoplasm.

CASE 2. Cervical polyp. Marked papillary overgrowth (Fig. 2). Slide was submitted to the laboratory for diagnosis. The surface is covered with stratified epithelium except in the area shown in Fig. 2, in which the stroma is scanty and there is an appearance of newly formed glands. Mucoid degeneration of the cells is marked. The atypical qualities are more apparent than in Case 1, but it is difficult to define its actual relation to a tumor process.

CASE 3. Epidermoid metaplasia in a cervical erosion. Pregnancy (Fig. 3).

Age 28. Pregnancy in third month. Atypical bleeding from the surface of an ectropion. A section of a small piece removed for diagnosis shows the surface is covered by a thin layer of stratified epithelium which is not more than three or four cells deep, the most superficial of which appear to be cylindrical. In close proximity to two normal glands and immediately beneath the surface epithelium, is a cluster of glands filled with epithelial cells that are not atypical enough to be designated cancer-nests, but more so than is usually seen in a simple erosion. The disproportionate amount of metaplasia in these glands as compared with that on the surface is alone an atypical change. It has been designated a precancerous change, and the clinician has been requested to make another diagnostic excision in a month.

CASE 4. Small mucous polyp. Cervical erosion. Excessive epidermoid metaplasia (Fig. 4).

Clinical history. Age 47, mother of 6 children, last 9 years ago. Menstruation scanty. Discharge for some time, lately tinged with blood. Cervix was slightly ectropic and just within the external os there was a very small polyp which was excised for diagnosis.

The histological examination shows a normal cylindrical epithelium changing abruptly into a slightly thickened stratified layer which presents considerable papillary downgrowth. The glands in this area are normal. In the area shown in Fig.

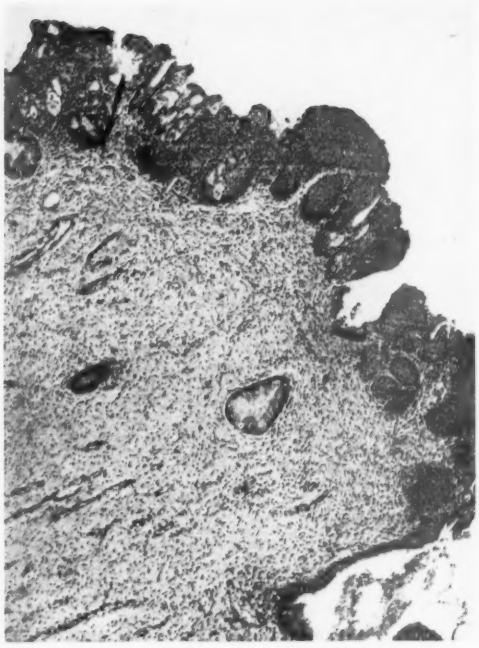

Fig. 7. Patches of cervical leucoplacia.

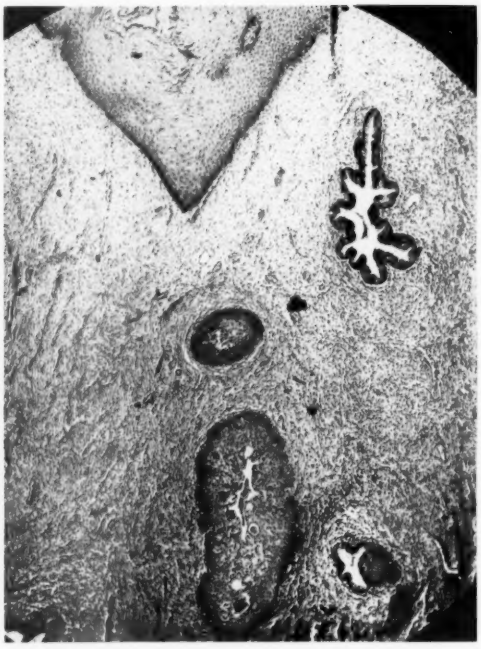

Fig. 8. Downgrowth from a completely epidermized surface.

4 there are numerous papillary outgrowths mostly covered with normal cylindrical epithelium, beneath which are numerous and irregular metaplastic glands,mingling apparently with similar metaplastic outgrowths from an underlying hypertrophic gland. There is no trace of hornification, but there is a proliferation of the deeper layers and a suggestive irregular outline to the glands. The quality of the cells, however, is mostly benign and the process appears to be a very atypical metaplastic change to which we would apply the term precancerous. The patient refused an amputation of the cervix, but there is every reason to believe that she is well, one year after the examination was made.

CASE 5. Cervical polyp. Extensive papillary and epidermoid proliferation (Fig. 5).

Clinical history not available. The papillary structure is excessive, showing numerous areas with little if any stroma between contiguous papillæ with apparently normal cells. In the field shown in Fig. 5, there is so much metaplasia and overgrowth that it is difficult to say that a carcinoma has not already become established. There are traces of heterotopia and stroma invasion.

CASE 6. Papillary endocervicitis. Miniature islands of epidermization (Fig. 6).

Slide submitted to the laboratory for diagnosis. Clinical history and gross material not available. The section shows the sign of a chronic inflammation and a slight papillary formation. The covering of cylindrical cells is generally well preserved. In one or two areas there are very small islands of epidermization which appear to be miniature foci of leucoplacia. In another section there is a larger island showing the same change. The interest in these sections relates to the changes seen in Cases 7 and 8.

CASE 7. Leucoplacia of the cervix. Papillary proliferation. History of syphilis (Figs. 7 and 8).

Clinical history. Age 50, married 27 years; 6 children, 5 miscarriages. Typhoid fever at 12, scarlet fever at 14, measles at 40. At 14 years of age ulcers which appeared on both legs persisted until she was 26. When 30 was in a hospital for 10 weeks with double otitis media and a disease of the throat which resulted in a perforation of the palate. From an investigation made at that time it was learned that both her father and mother had syphilis before she was born. A brother also had the disease. She was treated for syphilis periodically for some time thereafter. At 33 she married and two of her children died. Menstruation as a girl was painful and she had leucorrhœa. It has always been profuse and during the past five years irregular. The last period began seven weeks before admission to the hospital and continued for six weeks. She has recently had attacks of vertigo and pains in the legs,

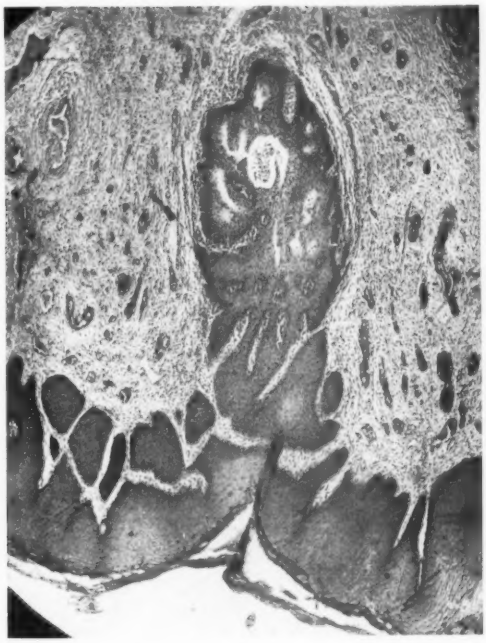

Fig. 9. Epidermization of the cervical mucosa. Leucoplacia.

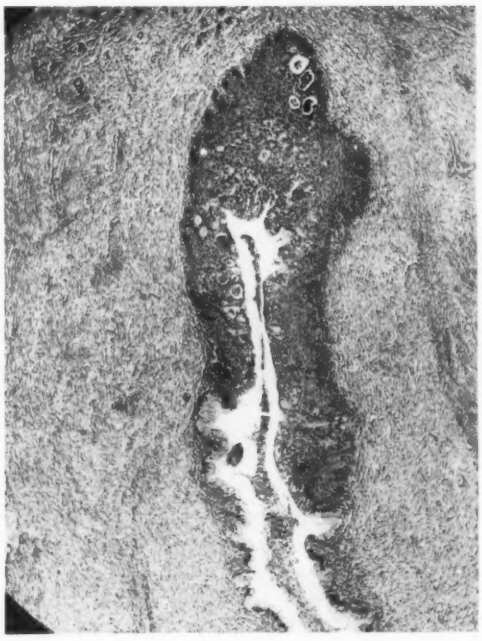

Fig. 10. Metaplasia and proliferation in deep isolated cervical gland. Periglandular interstitial inflammation.

especially marked in the left foot so that its use has been difficult.

Physical examination. There is a scar at the site of the perforation of the palate, and there are scars of old lesions in the neck posteriorly on the left side, and at the sites of the previous ulcers of the legs. There is no paralysis and there are no eye symptoms. The Wassermann test is positive. The uterus is large and retroverted. There is no thickening of the appendages. The cervix is badly "eroded" and presents some areas suspicious of carcinoma. A hysterectomy was performed. Gross appearance: The uterus is much enlarged but, with the exception of a small intramural fibroid above the cervix, there is no apparent tumor growth. The normal rugæ of the cervical mucosa have entirely disappeared, and its surface is covered with whitish yellow, slightly elevated patches, which are smaller in the region of the internal os. The mucosa of the corpus appears to be thin and congested.

Histology. Section of the cervical canal shows a moderately thickened layer of stratified epithelium with little tendency to downgrowth, overlying a few dilated glands and broken by the openings of a few slightly hypertrophic glands. The chief features are shown in Fig. 7, in which numerous islands of epidermization are seen lying on and within a papillary meshwork, the small papillæ joining each other in such a way as make apparent a mass of newly formed glands. At intervals normal glands open upon the meshwork, between which are small areas of epidermized glands appearing like epithelial nests. In another area, shown in Fig. 8, there is a downgrowth from a more completely epidermized surface, representing the metaplastic transformation of a gland, which because of the direction of the section resembles carcinoma-nests. The mucosa of the corpus shows only the changes of an atrophic endometritis. Some sections of the stroma show marked evidence of a chronic myositis. There is a focal overgrowth of small muscle-cells, with hyperchromatic nuclei, distended lymph channels, and numerous new blood-vessels with thickened walls. We have then in a case, giving a history of syphilis and other severe infections and presenting clinically strong suspicions of a cancer of the cervix, typical patches of leucoplacia, extending along the entire course of the cervical canal and grouped within areas of a papillary proliferation of epithelium. In other words, there are the prototypes of two forms of malignant change — epidermoid carcinoma and papillary adenocarcinoma of the cervix.

Case 8. Epidermization of the cervical mucosa. Leucoplacia. Pyosalpinx. Tubo-ovarian abscess (Fig. 9).

Fig. 11. Precancerous gland hyperplasia of corpus.

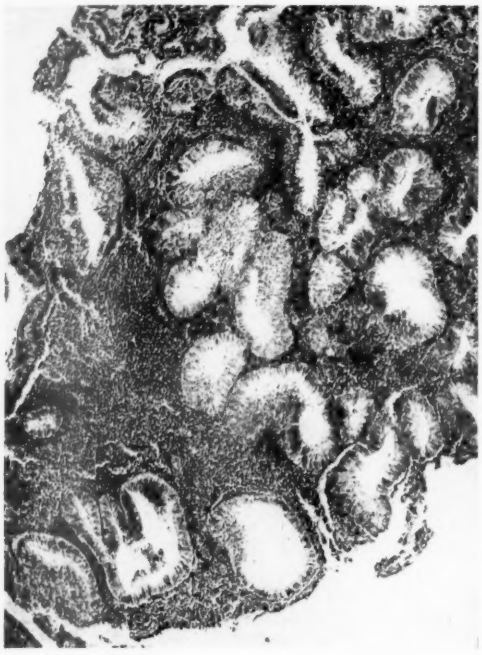

Fig. 12. Advanced precancerous hyperplasia of corpus.

Clinical history. Age 33, single, no children. Had complained of profuse menstruation, discharge and pelvic pain. No history of syphilis. The examination showed a large hard cervix which was markedly "eroded." A clinical diagnosis of chronic endocervicitis with erosion was made and the cervix was amputated. Diseased appendages were subsequently discovered and an operation revealed a tubo-ovarian abscess on one side and a pyosalpinx on the other. The gross material is not available.

Histology. A section of the cervix shows the cervical mucosa transformed into a thickened layer of stratified squamous epithelium, with a marked tendency in areas to hornification and well marked papillary downgrowth. In the field shown in Fig. 9, the metaplasia has extended into a gland, around the lower end of which is a thin layer of round-cell infiltration. The stroma shows marked hyperplastic change with numerous blood-vessels and perivascular areas of fibrosis. The cells of the epithelial layers are well defined but the basal cells show a slight proliferation in some places. If a similar process covered the entire mucosa of the corpus, it would present a picture not unlike that in von Rosthorn's (34) case of icthyosis, which Hitschmann (22) and others have said was an established carcinoma.

CASE 9. Isolated cervical gland showing metaplasia and proliferation. Periglandular interstitial inflammation (Fig. 10).

No information is available regarding the clinical history or gross material. The gland appears to be isolated within the deep structure of the cervix, and partly transformed into a stratified epithelium which gives some evidence of proliferation. The quality of the cells is slightly atypical. In other sections there is a normal stratified surface epithelium overlying two or three superficial normal glands and follicles. An accurate interpretation of the changes in this gland is impossible to make, but there is an undoubted relation between the epithelial changes and the periglandular interstitial inflammation. As a prototype of a tumor growth we think of those cases in which a malignant growth begins clinically as a hard nodule within the stroma of the cervix.

CASE 10. Precancerous gland hyperplasia of corpus. Clinical history suspicious of cancer (Fig. 11).

Clinical history. Age 52. Menopause occurred seven years previously. There had been continuous bleeding for eight weeks. Has been curetted three times, the last one week ago, after which the bleeding ceased and has not yet recurred. The enlarged size of the uterus, however, has not yet diminished. The material removed by the first two curettings is said by a competent pathologist to present the same picture as that from the last operation which was sent to the laboratory for diagnosis.

Histology. There is advanced glandular hypertrophy and hyperplasia throughout all of the areas. The stroma, however, is abundant except in a few places where the glands have become dilated into small cystic cavities lined by one layer of low cuboidal epithelium. In the area shown in Fig. 11, although there is no appreciable difference in the amount of interstitial stroma, the glandular struc-

Fig. 13. Atypical proliferation. Acute endometritis.

Fig. 14. Beginning adenoma of the cervix.

ture is essentially altered. The epithelial outgrowths and ingrowths become a more distinct feature. The cells show a definite tendency to assume an irregular form, to increase in size and to proliferate into more than one layer, and the nuclei are hyperchromatic. Now and then there are traces of breaking through the membrana propria. This case illustrates the immediately practical side of the problem. With such a clinical history the decision relative to therapy should be made by a competent clinician, provided he has a proper appreciation of the histologist's interpretation of the expression "precancerous." In this case a delay in radical surgical measures is planned.

CASE 11. Advanced precancerous hyperplasia of corpus. Fibromyoma (Fig. 12).

Age 37. Atypical bleeding. The uterus is much larger than normal, presumably because of the presence of an intramural fibroid.

Histology. The curetted material is decidedly different from that of Case 10, but it is doubtful if a macroscopic growth other than the fibroid will be found. The gland hyperplasia is considerably more advanced, but in numerous areas the stroma is sufficiently abundant to exclude a tumor process. In the area shown in Fig. 12 the glands are close together, but the cells maintain a better alignment than they do in Case 10. Their altered qualities are chiefly expressed by the changes in the staining qualities of the cell protoplasm. Ingrowths and outgrowths are numerous and there appears to be a tendency to form more than one layer. Heterotopia is faintly expressed. Because of the presence of the fibroid, the decision in regard to the correct therapeutic procedure is easier to make. Unfortunately we have not yet received the gross specimen because the patient has thus far refused a radical operation.

CASE 12. Atypical epithelial proliferation. Acute endometritis (Fig. 13).

Clinical history. Age 28. One child six years previously. Several attempts have been made during the past year to hasten delayed menstrual periods. Atypical bleeding for several weeks. Curettage was performed.

Histology. The changes are mostly those of an acute endometritis. In a few areas, however, there are traces of epithelial overgrowth, in which the normal quality of the cells is altered, showing a few large irregular and hyperchromatic nuclei, clumped not unlike that seen in giant-cell formation (Fig. 13). From the benign character of the clinical history and the presence of an acute endometritis, we are unable to attach much serious importance to these focal changes.

CASE 13. Beginning adenoma of the cervix (Fig. 14).

The clinical history and gross material are not

available. The section is that of a cervix with normal surface epithelium and a few superficial erosion follicles. In Fig. 14, there is shown gland hypertrophy and hyperplasia of sufficient amount to closely approach that found in a tumor growth. It is situated deeply within the stroma, without signs of inflammatory change. The lining cells everywhere preserve the normal type of mucous cells. It seems not improbable that such a process is a prototype of that infrequent form of adenoma of the cervix, in which the mucous cells preserve their normal type after the glandular growth has reached bulky proportions and become clinically malignant.

SUMMARY

It seems to the writer that the evidence in the literature and the material which he has presented justifies the following comments.

1. As the positive identification of a malignant neoplasm can not be made histologically until definite destructive capacity is recognized it seems reasonable to relate more definitely the other histological criteria of cancer to the developmental stage of its growth, the closeness of the relation in a specific case depending upon the quality and quantity of such criteria as may be present.

2. If so, we find in the study of uterine pathology numerous morphological alterations of epithelial growth which differ but little from the regenerative activity of benign lesions, but which after a longer or shorter time show features that are differentiated with difficulty from the alterations we know typify malignant neoplasm.

3. The strongest support of this assumption is derived from the reproduction of types which are seen in the different stages of their progress. We find the atypical features of a healing erosion, for example, determined by the original type of the primary erosion — simple, papillary, follicular; and we find the atypical types again reproduced in the different types of fully established uterine cancer. In the writer's cases, there are atypical healing erosions which are prototypes of either an epidermoid cancer or a papillary adenocarcinoma. There are leucoplacias which are prototypes of adult acanthomata. There are glandular hyperplasias which lead to adenoma or adenocarcinoma. Finally, there are focal areas of leucoplacia, combined with adenomatous hyperplasia, which may well furnish an origin for tumors designated as adeno-acanthomata. In short, for each type of fully developed carcinoma there is a corresponding type of benign and intermediary change.

4. Clinical observation increasingly confirms the sequence of definite benign lesions in the uterus and cancer, but its evidence is thus far too scanty either to confirm or deny their histogenetic relations. In order to work out this problem a closer co-operation is required between the clinician and the pathologist, with the idea constantly in mind that the morphological features of intermediary stages may exist. It is no argument against such an assumption because no tumor process presents or follows in a given case. The evidence is already sufficient to show that a fully established cancer may exist for a certain time without giving gross evidence of its presence, and numerous cases are recorded in which the curette has completely removed the disease.

5. There is no reason to assume that precancerous changes without treatment always develop into malignant growths. We know different types of fully established tumors have a different capacity to grow and destroy rapidly or slowly, and it does not seem reasonable to assume that a developing cancer has the same momentum that a fully established tumor possesses.

6. In the study of beginning cancer of the uterus, Sitzenfrey (20), Schauenstein (21), Schottlaender-Kermauner (4), and Pronai (53) direct attention to the important observation that a certain type of early cancer spreads superficially over wide areas before showing marked invasive feature. It has occurred to the writer that such a mode of growth may account in some measure for the widespread extent of the process before it receives the attention of the clinician.

7. From a practical standpoint, the decision regarding the proper therapeutic procedure in these cases should be assumed by a competent clinician.

The writer desires to express an appreciation of his indebtedness to Professor James Ewing for numerous criticisms and suggestions; and

also to thank Drs. L'Esperance, Caturani, and Mallett for much of the clinical and pathological material.

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A DETAILED STUDY OF THE PATHOLOGICAL CAUSES OF STERILITY WITH THE END-RESULTS[1]

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PROBABLY no question is of such sociological significance to the gynecologist as that of sterility. Homes are wrecked, lives are sacrificed, and fortunes lost, all because of the inability of a woman to conceive or to successfully bring forth the fruits of her conception. Certainly no subject taxes the resourcefulness and ingenuity of the gynecologist more. Do what we will, many women from one cause or another are destined to remain fruitless.

It would seem from an extensive study of our case records that the number of sterile women is increasing, at least, an increasing number is applying for relief. Yet a large majority of those who apply present such gross lesions that little or nothing can be done to help them.

We may define sterility as the inability on the part of the woman to produce a living child. This inclusive definition is propounded so that we may include in this discussion the part which syphilis plays in the etiology. Sterility may further be divided into the so-

[1] Read before the American Gynecological Society, Washington, May, 1916.

called primary sterility, where the woman has never been pregnant, and the secondary type where she has borne a child or has had a miscarriage and remains sterile thereafter. In this study, which is a personal review of 798 case histories of patients from the writer's private practice, we will attempt *first* to analyze the many etiological factors which have entered into the causation of this symptom; *second*, to discuss the treatment of the individual case based upon an etiological diagnosis, and *finally*, to summarize our end-results, in the hope that this contribution may add something to this already overwritten but unsolved subject.

It must be primarily admitted that conception depends *first* upon the perfect consummation of the sexual act; *second*, on the proper fecundation of the ovum, and *third* on the proper nourishment of the impregnated ovum during its growth and development after its final location in the decidual bed. It is thus apparent that certain conditions are essential for conception. Findley has tersely summarized these as follows:

1. The deposit of semen containing active, living spermatozoa in the upper portion of the vagina.

2. The passage of the healthy spermatozoa to the ovule, through the cervix, into the cavity of the uterus and into the tube.

3. A healthy ovum which has uninterrupted transit from the ovary, and after impregnation, through the tube into the uterine cavity.

4. A decidual bed for the impregnated ovum to find a permanent resting place in the endometrium until the period of viability.

These conditions entail a healthy male, producing a healthy, active, well-developed long ciliated spermatozoid capable of rapid movement through the semen. Furthermore, the seminal discharge should be free from infective bacteria. For these reasons, the husband of each woman in this series has been subjected to a most exacting examination by a competent urologist. This examination has not only included an investigation as to the potency but as to the presence of past or present infective disease. The passage of the spermatozoon through the cervix is dependent upon the activity of the particular spermatozoon and the *amount, character, and reaction of the glandular secretion from the cervix.* Acids in very weak dilutions are destructive to the spermatozoa and thick muco-pus acts as an almost insurmountable barrier to the progress of the male element.

Proper ovulation depends on the efficiency of the individual ovary. This implies a healthy egg-bearing area and the free delivery of the ovule through the ovarian tunic. Consequently conditions which have resulted in a thickening of the tunic militate against conception. Chronic inflammatory changes, prolonged acute infection, fatty degeneration, tumors, adhesions, and senile atrophy all impair the egg-producing quality of the ovary as well as tend to thicken the tunic to such an extent that ovular rupture may be prevented.

The proper transit of the ovum from the ovary to the uterus requires a healthy patent fallopian tube. Fecundation is supposed to take place at the outer end of the fallopian tube, from whence the impregnated ovum is propelled along the course of the tube into the uterus, where the endometrium has been prepared by the development of a decidua for its reception and permanent nutrition. Hence, conditions which interfere with this free transit may be accepted as causes of sterility. While a tube may not be patent to an impregnated ovum, its lumen may still be sufficient to allow the passage of the spermatozoon and impregnation of the ovule in its distal portion. This is shown by the great frequency of tubal pregnancies, occurring after long periods of sterility which are due to the results of chronic inflammatory disease.

The conditions of the tube which may impair the transmission of the impregnated ovum are either congenital or acquired. Of the former we may mention tortions, constrictions, angulations, and diverticula, while acquired lesions are commonly the result of inflammatory processes, which either occlude the lumen or destroy the epithelial lining of the tube, or produce peritubal adhesions which distort the tube and thus prevent the passage of the ovum.

On arriving in the uterus, the impregnated ovum locates in the decidual bed prepared for its nourishment, which usually is situated just below the uterine ostium of the tube on the anterior or posterior wall of the uterus, and unless the endometrium has been the seat of disease the ovum develops at the site of its primary implantation. Syphilis of the endometrium may prevent implantation of the ovum or cause its early discharge from the uterus. Circulatory derangements which produce hyperplastic and fungoid changes in the endometrium contribute largely to the unrest of the ovum. These circulatory changes may be produced by displacements, fibroid tumors, sexual excesses, lacerations, and subinvolutions, and result in an endometrial hyperplasia. Such conditions change the character of the uterine secretion, producing toxic discharges from the involved surfaces of both the body and cervix, which may cause the death of the sperm cell, and thus produce another factor which is antagonistic to the occurrence of pregnancy.

The foregoing may therefore be considered the essential factors in the fecundation and the development of the impregnated ovum. Hence, it may be deduced that where any of these elements are defective, sterility may result. McDonald claims that there is primarily a congenital anomaly (hypoplasia of the genitalia) in the etiology of all cases of primary sterility. This, however, has not been the experience of the writer who has found that a preceding salpingitis has been responsible for more cases of sterility than all other causes combined.

It is commonly admitted that the general health of the woman has much to do with the occurrence of pregnancy. It is also known that men become less potent from the strain of overwork, and that nervous excitability decreases the individual's potency. Women who have become rapidly obese are not infrequently sterile. Hence it will be seen that each individual case must be analyzed as to its etiology before any form of treatment can be considered, and this analysis must include an investigation of both contracting parties, for in our opinion, the operative treatment of a woman for sterility alone, without the actual inspection of her husband's spermatozoa, is not only unjustifiable but frequently does actual harm to that woman and brings discredit to gynecology. Reynolds in a recent paper presented before the obstetric section of the American Medical Association offers the following working hypothesis for determining the cause of sterility in the individual case.

1. He states that when the spermatozoa are abundant in number, normal in form and appearance, furnished with long cilia and capable of rapid movement through the semen, the male may be considered as *satisfactorily potent.* While this is essentially true, our experience has taught us that the presence of infective bacteria in the semen or prostatic discharge, even if the spermatozoa are well formed, will often vitiate their potency because of the effect produced by these bacteria on the generative organs of the receiving female.

2. When the normal spermatozoa are killed or lose their vitality overrapidly in the secretions of the individual woman, the chemicophysiologic character of her secretions furnishes an effective cause for the sterility.

These alterations in the secretions of the woman which are fatal to the spermatozoa may be located in the vagina, in the cervix, in the body of the uterus, or in one or both tubes. Any of these secretions may exist with normal secretions above it, but alterations in the secreting surface in any of these localities, usually vitiates all the secretions below it owing to the admixture which takes place, for acids in very weak dilution are rapidly fatal to the spermatozoa. Finally, when the spermatozoa are observed to penetrate without apparent loss of vitality, to the fundus of the uterus and to survive there, for a normal length of time, *deficient quality of the ova* may be considered as the probable cause of the sterility. Lade estimates that there are 227,500,000 spermatozoids in a single ejaculation, and it is stated that the spermatozoa will not live longer than twelve hours in the acid secretion of the vagina, yet in the normal secretion of the uterus and the tubes, they will commonly retain their activity and vitality for six or eight days. In

Leopold's case, the woman had not had sexual intercourse for thirty-seven days prior to the abdominal section which he performed, when active living spermatozoa were found in large numbers in the fimbrinated end of the tube. We have frequently noted during microscopic examination of the withdrawn semen, the effect of the mucopurulent secretion from an infected cervix on the activity and life history of the spermatozoa. They may be seen struggling around trying to free themselves from the sticky mucus, and finally exhausted from their struggle to push on, die. Hence we feel that the tight fitting plug of mucus in endocervicitis is a real obstacle to the advance of the spermatozoid. Lespinasse claims that the secretions in different women dissolve the spermatozoa of different men and thus produce a sort of immunity action. This is probably the explanation of why certain healthy women fail to conceive by apparently healthy males and then upon remarriage promptly conceive.

Huehner has checked up the progress of the spermatozoid by microscopic examination of the spermatozoa *in situ*, in the genitals of the woman, by taking the woman's secretions at different locations at definite periods after the intercourse, and in this way has determined the action of the secretions and the comparative vitality of the spermatozoa at different locations in the genital tract. This has in his experiments given a direct index of the chemicophysiologic action of the individual secretions and affords valuable evidence as to the possibility of impregnation in a particular case.

While acute anteflexion of the cervix, infracervical hypertrophy and pronounced retroversion of the uterus act as causes of sterility by mechanically removing the cervix from its position in the seminal lake, they will not prevent conception unless there is some change in the chemicophysiologic action of the cervicovaginal discharge.

Aside from these factors already referred to, certain clinical observations are worthy of mention, as they contribute materially in determining the value of treatment. The average interval between marriage and the birth of the first child is seventeen months and the probability of impregnation decreases thereafter. Only 25 per cent of women bear their first child after four years. Therefore, a union may be regarded as presumptively sterile when after three years of married life no child has been born. Hypoplasia of the genitalia is a common cause of sterility. Infantilism may be found in the uterus alone, or in the uterus, vagina, and external genitals, or associated with other evidence of congenital hypoplasia as loose right kidney, justominor or funnel pelvis, long back, "cannonball" abdomen, intestinal ptosis, small head, weak ligaments, high-roofed mouth, under weight, and unstable nervous system. When the uterus is *infantile*, it retains the shape and appearance of the uterus of the girl before puberty. It may take one of two types; it may be long and slender with a small fundus, a long isthmus and a long conical cervix, or it may be shorter with a long isthmus, small fundus and a small cervix, with most of the cervix placed above the insertion of the vagina and but little projecting into it. The first type has usually a marked anteflexion while the second is frequently associated with marked narrowing of the vagina in its upper part. The infantile uterus usually has a long isthmus with the plicæ palmatæ of the mucosa of the isthmus well marked and longitudinal instead of being thin and horizontal or twisted. The vagina is commonly involved with infantilism of the uterus. This takes the form of a narrowing, particularly of the upper part of the vagina, thus obliterating the seminal lake, consequently instead of being balloon or pear shaped with the largest end upward, the vagina is tubular or sausage-shaped. As a result of this the semen is not retained where it should be after coitus, but is expelled from the vagina. Fruitful normal women retain the semen, while sterile women usually lose it. The vulva may also show signs of infantilism, e.g., lack of development of the labia majora or labia minora.

In managing our cases of sterility, we have begun with a thorough investigation of the life and functions of both contracting parties. In no case included in this report was the examination of the male omitted. These examinations were conducted by J. S. Read

and include investigation as to the past performances of the man as well as for his present potency; for *men who have infective bacteria in their prostatic secretion can produce such inflammatory changes in the female genitalia as to prevent all hope of future pregnancy.*

Unless the man was potent, no attempt was made to improve the condition of the woman as regards her sterility, though many women were operated on for the cure of complicating lesions. If the man was found potent, the woman was put through a thorough and painstaking routine, beginning with her previous history, including the history of her development, illnesses, nutrition, habits, occupation, rest, and general health. Inquiry was always made into the habits of her sexual life. This was followed by a general examination of the heart, lungs, nervous system, stature, nutrition, whether emaciated or obese, and followed by a pelvic examination to determine the presence of anomalies at the vulva, of the vagina, in the cervix or uterus, or the presence of the results of infection, as shown in Skene's glands, in Bartholin's glands, in the cervix, in the uterus, tubes, ovaries, and adjacent peritoneum.

The reaction of the vaginal and cervical secretions was thoroughly investigated and the presence of gross pathology in the fornices noted. A Wassermann test was made in all of those who presented themselves with histories of abortions or premature labors with death of the fœtus. To make this study 798 case records have been reviewed. Two hundred and thirty-one were found to be inaccurate or incomplete, the patients failing to return for subsequent examination or the husband's record having been omitted, or for some such reason these histories were excluded from our consideration, making a total of 567 from which we can draw our conclusions. From this number, however, there must be some further deductions, such as those cases where the man was impotent, having aspermia, or deformed and sluggish spermatozoa, or where the original infection remained uncured. These cases total up to 64. Furthermore, we have excluded those women who were found to have such gross lesions of the uterus and adnexa as to bar them from even the possibility of pregnancy, and those constitutional conditions as cardiac decompensation and diabetes, which should forbid conception. Of the former there were 70; of the latter 6. Subtracting these cases, we begin with 427 women in whom pregnancy is a possibility. Many of these, however, presented such pathology that we could not say that conception was even probable. For this reason I propose to consider the etiology and the end-results of the several forms of treatment instituted in two general classes. In the one we will include infantilism and congenital anomalies, 73; normal pelvis, free from circulatory or inflammatory complications, 146; uncomplicated retroversions, 20; and infracervical hypertrophy, 5; making 244 in all. While in the second class we will place the remaining 183 cases, all of whom presented some evidence of the results of an infective process at one or more locations along the genital tract. It is intensely interesting to note the frequency with which infection has invaded these several susceptible points. Our records show that the glands at the introitus were infected 43 times, while 104 presented an endocervicitis with a mucopurulent discharge. These were complicated with a posterior parametritis in 78 instances. Fibroid tumors of varying size and of the subperitoneal type, producing no symptoms and only discovered in the course of the examination, were recorded in 54 cases. Ovarian cysts varying in size from that of an orange to that of a seven months' pregnancy, was the apparent cause of sterility in ten instances. The results of infective processes in the tubes were found in 96 cases. These were almost always associated with inflammatory or cystic changes in the ovary. In 11 cases the tubal infection had extended to the pelvic peritoneum and the patient, though presenting no gross lesion which was palpable at the examination, was the subject of recurrent attacks of pelvic peritonitis. In each of these cases a double hydrosalpinx was the resulting lesion. Retrodisplacement of the uterus complicated by tubal or ovarian disease was noted in 61 women. Prolapsed ovaries, palpable and tender, often producing

severe dyspareunia, were relatively frequent, as we find that they were noted as a complicating lesion in 92 histories. Only three patients with acute vaginal inflammation presented themselves. In 2 of these the Neisserian bacillus was isolated. The other showed numberless diplococci that would not stain gram negative.

In the first class which includes all the cases of infantilism, mention should be made of the frequent association of bony pelvic anomaly. Funnel pelvis, male pelvis and justo-minor contraction were noted with such frequency that we feel that the subject should have more consideration than has been given it by the gynecologist in the past, for it seems questionable when a woman has a definite bony pelvic deformity, whether we are right in employing operative measures for the cure of her sterility when we know she will have a difficult operative labor. Certainly the patient or her husband has a right to the knowledge of these facts. In the 73 cases recorded as having an infantile uterus, bony pelvic anomaly was recorded 41 times. This was shown in the short external measurements, the depth of the symphysis pubes, a narrow subpubic arch, the short bisischial diameter or faulty inclination of the pelvic brim.

TREATMENT

The treatment, as may be supposed from a glance at the foregoing statements, was in all cases directed toward the correction of the existing causative lesion. In the first class, this included the employment of alkaline douches, of the graduated dilators, the Baldwin or Davenport stem, discission of the cervix, after the methods of Dudley or Pozzi, amputation of the cervix, and correction of uterine displacements.

In the second class both local and operative measures were employed. In those cases of uncomplicated cervicitis and endocervicitis where the tenacious mucous plug presented the obstructing lesion, the mucous was removed with peroxide of hydrogen on a rotary applicator or with a Bier suction apparatus and the mucosa sterilized and an iodized phenol solution applied and the patient directed to follow this application with douches in the recumbent position before reretiring, using a solution of bicarbonate of soda, a tablespoonful of the soda to a quart of water. Vaccines and destruction of the cysts with the electric cautery knife have also been employed, but our best results have been obtained from simple antiseptic measures. Women who have repeatedly aborted, in whom the Wassermann test was reported negative, were curetted and the cavity of the uterus thoroughly iodized by packing the uterus with strip gauze soaked in iodine. *This was left in place for twenty minutes* and was then removed. These patients were then advised not to cohabit for a period of three months. In the meantime, special attention was given to improving the condition of their general health, by exercise, tonics and fresh air. Those presenting large fibroids not involving the uterine cavity, had the tumor removed by myomectomy. Small tumors received no surgical consideration. In the 10 cases of large ovarian cyst, unilateral oophorectomy resulted in 8 of the women becoming pregnant. From this observation it would seem that a large cyst of one ovary militated against the proper functioning of the other ovary, until that cyst was removed. Infective processes in the tubes were dealt with by unilateral ablation, bilateral ablation with resection of the uterine ends or of the fundal segment of the uterus, or by salpingostomy. Frequently it was found that the inflammatory process had passed through the tube, and time had allowed considerable resorption, and that it was the resulting adhesions which had closed the abdominal ostium and embarrasses the ovarian function. Freeing these and suspending the ovary has frequently resulted in pregnancy. In the series of retroversions complicated by tubal and ovarian disease, all the women were subjected to abdominal exploration and investigation. In these the tubes were freed from adhesions, ablated or resected, the ovaries suspended after the method suggested by my associate, William P. Pool, and the round ligaments shortened by following one of the techniques suggested by Webster, Gilliam-Montgomery, Coffey, or Neel.

Of the cases of prolapsed ovary we have

found that an ovary out of place has its tunic thickened from circulatory stasis, so we have been in the habit of suspending such ovaries after puncture of the superficial cysts, to reduce their weight and have thus established a better ovarian circulation. No resections have been done except in six cases of large white ovary, in obese women with amenorrhœa, where the tunic was extensively thickened. In these cases a large wedge-shaped piece of the cortex was removed and the area of excision closed with fine catgut sutures. This has re-established menstruation in all six cases and resulted in a pregnancy in three.

In the 73 cases of congenital anomalies, which include extreme antiflexion of the cervix, with deep posterior invagination, antiflexion of the body and cervix, and infantile uterus, the following corrective operations were done: In the antiflexions of the cervix in which the invagination of the posterior lip was 4 to 5 centimeters or more in length, a posterior discission after Dudley's technique was always elected in order that the cervical os, so constructed, could be placed in the seminal lake. In the antiflexions of the body alone we have elected Reynolds' procedure combined with the use of the intra-uterine stem (Baldwin). In antiflexions of the body and cervix our procedure has always been dependent upon the amount of cervical invagination. If this was considerable, a posterior discission in conjunction with the Reynolds anterior colpotomy will straighten the canal. On the other hand, when the portio was short, gradual dilatation, an anterior colpoplasty, and the introduction of a glass stem often produced relief.

In the true infantile uterus it is questionable whether much should be done. Our only pregnancy results in this type have been two *ectopics* and five miscarriages, for not only is the anomaly in the uterus, but in tubes, ovaries, and vagina, and the dysmenorrhœa which is prominent, is only temporarily relieved by operation. In this class we doubt if any plastic procedure is of much avail, as we have found that the presence of scars in a small vagina, embarrasses sexual relations. *Slow dilatation* with Hegar's sound, up to 16 to 20 millimeters, and the introduction of a Davenport stem, has afforded some relief, but no infantile uterus in this series has developed a pregnancy and gone to term. Seven have conceived, the two ectopics referred to above, and in 5 the impregnated ovule has reached the uterus and developed there, only to end in an abortion at the second or third period.

Included also in our first general classification are 146 normal pelves free from circulatory or inflammatory changes of any sort. These women had been married for periods of three years or more and had never been pregnant, before applying to us for relief. The husbands were potent. The reaction of the secretion of the vaginal vault was determined in each case. One hundred and nine showed varying degrees of acidity. Examination of the semen *in situ* in these cases *showed* many immobile spermatozoa. *In all who gave an acid reaction* alkaline douches of soda-bicarbonate and soda phosphate, one ounce to the quart, were advised to be taken on a douche pan, after retiring. Pregnancy resulted in 75 or about 70 per cent, making this our most successful series. Thirty-seven showed no change in secretion, yet only 4 have become pregnant as the result of local treatment. No operative procedure of any sort was done in this apparently normal pelvis class. This rather goes to confirm the theory that certain women are immune to impregnation by certain men.

Of the 20 uncomplicated retroversions, 11 were repositable and could be maintained in position with a pessary. Six of these women became pregnant, while 9, because of a deep posterior invagination of the cervix, could not be held in place with a support. These were operated on by the Webster-Baldy or Gilliam technique and a Dudley discission. Of these, 5 have become pregnant. This shows conclusively to my mind that the position of a cervix in its relation to the seminal lake has much to do with conception, provided the secretions are not destructive to the life of the spermatozoa.

Infravaginal hypertrophy of the portio has given us not only the best surgical cures, but amputation of the hypertrophied portion of the cervix has been followed by pregnancy,

going to term, in each of our cases (5 in all).

In the second class made up of 183 women presenting some evidence of the results of an infective process, post-partal, post-abortal, or gonococcic in origin, pregnancy has been relatively infrequent. Of the 104 women subjects of endocervicitis with a mucopurulent discharge, only 21 became pregnant. Eight conceived as a result of one local treatment in which the mucous plug was removed with a bicarbonate paste, and the canal swabbed with iodized phenol. Three became pregnant promptly after the glands were destroyed with the cautery, and 10 following the persistent use of the carbonate of soda douche.

Of the 90 cases which were found to have the results of infective processes in the tubes, uterosacral ligaments, and cervical canal, the intra-uterine and tubal pregnancies are equally divided, there being three of each. The abdomen was opened in all of these patients because of the history, not because of the gross pelvic findings. There was invariably present a history of infection, with sterility, dyspareunia, and local discharge. Tubal ablations were done 35 times, resections 31 times, and freeing of adhesions in 30. Two ectopics occurred in resected tubes, against 3 intra-uterine pregnancies. One ectopic occurred in a freed tube, but no uterine pregnancy. Of the 54 fibroids, myomectomy was done in 20 and hysterectomy in 34. Six pregnancies occurred following myomectomy, 4 going to term. Following the 10 unilateral oophorectomies for large ovarian cysts, 8 women became pregnant.

One hundred and thirty-two uterine, and 3 ectopics are the sum total of pregnancies occurring in 358 women in whom conception was a probability, or 37 per cent.

This study has shown us that—

1. A very large number of the sterility cases applying for relief have no chance whatever of becoming pregnant, as the pathology is such as to make conception impossible.
2. The male is largely responsible for our poor results in treatment.
3. There is a definite chemicophysiologic factor in conception, at present unexplainable, which is a cause of preventing conception.
4. Operative procedures on the uterus, except amputation of the hypertrophied portio, have but a slight influence on the end-results in the treatment of sterility; and finally, that each case must be individualized and both contracting parties carefully studied before any treatment is inaugurated.

SYPHILIS OF THE BODY OF THE UTERUS[1]

By CHARLES C. NORRIS, M.D., F.A.C.S., Philadelphia

FREQUENCY

THE antiquity and frequency of syphilis is well known. It has been estimated that from 10 to 15 per cent of the urban population of certain European cities is syphilitic. In some of the hospitals in this country the percentage has been found considerably higher than this. The disease is from two to four times more frequent in men than in women; probably from 1 to 4 per cent in women would be a conservative estimate.

It is only since the discovery of the spirochæta pallida in 1905 and the development of the Wassermann test two years later that the true frequency of this form of infection has become recognized.

In spite of the prevalence of syphilis it is remarkable how seldom the disease has been observed in the body of the uterus. In a review of the literature one cannot but be impressed by the paucity of reference and our incomplete knowledge of this subject. A review of the *Index of the Surgeon General's Library* to 1914 showed but thirty-six references by thirty-one authors, and reference to the *Index Medicus* from 1909 to date disclosed only eight contributions to the sub-

[1] Read before the American Gynecological Society, Washington, May 10, 1916.

ject. The majority of the modern gynecologic textbooks have either no reference to syphilis of the body of the uterus or at most the subject is dismissed in a few sentences. A pleasing exception is noted in the recent work of Krankl[1] in which a chapter is devoted to syphilis of the uterus. This contains an excellent review of the literature. Our reviews showed rather frequent reference to syphilitic manifestations localized in the cervix, such as chancre, mucous patch, gumma, and a condition which the obstetricians term "rigid cervix" which is prone to produce dystocia. Lesions of the cervix, however, do not fall within the scope of this paper, so that we shall omit them and consider only syphilis of the uterine body.

PATHOLOGY

Various classifications for the syphilitic lesions of the body of the uterus have been suggested. The amount of material from which to draw conclusions is as yet rather small. Many cases have been reported as syphilis of the uterus which are at least of doubtful authenticity. This is especially so of the period prior to 1905. In many cases uterine hæmorrhages have been attributed to syphilis which are open to doubt.

It is theoretically possible that the endometrium may be the seat of a primary sore. This is, however, unproved. The fact that the spirochæta pallida may become attached to or even possibly enter spermatozoa is well recognized. In recent years the frequency with which cases of syphilitic infection in women without evidence of a primary sore being demonstrable have been recorded make this possibility worthy of consideration. On the other hand it is well proved that the spirochæta pallida exhibits a strong predilection for squamous epithelium in the primary infection. This, however, may be the result of misplaced reasoning as the areas naturally most exposed to chancre are covered with this type of tissue. Two other explanations offer themselves for those cases in which no primary sore has been demonstrated; the one that the disease has been hereditary and the other that the chancre has been present in the vagina or cervix and has been overlooked. The fact that chancres produce mild symptoms and are consequently not looked for, offers a probable explanation in many cases. It must be remembered that in women a chancre does not leave behind it such definite evidence of its previous existence as it does in men and that the period of its existence is more transitory than in the male. The possibility of the primary sore occurring within the body of the uterus should however be considered.

In 1911 Hoffman[2] presented before the Society of Obstetricians and Gynecologists in Berlin an interesting specimen of gummatous endometritis. The patient from whom this specimen was obtained died of chronic sepsis a few weeks after delivery. At postmortem, gummata and other evidences of syphilis were demonstrated in organs other than the genital tract. The endometrium in this case contained numerous small gummatous-like tumors, the tissue lying between these was infiltrated with small round cells and presented other evidences of a subacute or chronic inflammatory reaction. For the most part the normal constituents of the endometrium were unrecognizable being replaced by the gummatous tissue. This in some areas was two or more centimeters in thickness. The entire endometrial cavity was more or less involved. The uterine body was enlarged and softened.

A more common form of syphilitic endometritis manifests itself by changes in the glands and stroma, the latter being chiefly involved. It is characterized by changes in the blood-vessel walls, and condensation of the stroma. Exactly how frequently this condition exists is not known. Chase's[3] recent conclusions regarding the frequency of syphilitic endometritis in general require further confirmation. Recasen[4] has described a form of syphilitic endometritis in which the mucosa is thickened and hyperplastic. Ulceration of the endometrium is not infrequent and resulting scars may also be

[1] Liepmann's Kurzgefasstes Handbuch der gesamten Frauenheilkunde. Leipzig: 1914, ii, 106.

[2] Hoffmann. Ztschr. f. Geburtsh. u. Gynaek., Stuttg., 1911, lxix, 482.

[3] Chase, J. C. Tex. St. J. M., 1913, ix, 95.

[4] Recasen, S. Ann. d. Acad. de obst. (etc.), Madrid, 1911, iv, 105.

observed. This is particularly likely to result during the tertiary stage. Such lesions have been described by Franceschini.[1] The histologic picture in specimens of syphilitic endometritis probably varies not only with the stage of the disease but with the period of the menstrual cycle in which the tissue is examined. The underlying musculature is usually more or less involved. Whether or not mucous patches or other secondary manifestations occur in the corporal endometrium is unknown. Many authors[2] (Franceschini, Chiarleoni, Rille, Fasola, Spinelli, Morisani and La Torre) believe that such lesions are not uncommon and that in some instances they produce leucorrhœa, dysmenorrhœa, and uterine pain.

Lesions of the myometrium may be divided into (1) a more or less diffuse metritis which is usually accompanied by an inflammation of the endometrium, and (2) gummata. In the former condition the uterus retains its normal shape, it may or may not be enlarged and is usually harder and firmer than normal. In at least one reported case the uterus was atrophic. The walls of the uterus are lacking in their normal elasticity and in some instances have been almost cartilaginous in consistency. An œdema of the uterus and peri-uterine tissues has also been observed. In syphilitic metritis the blood-vessels as a rule present the chief changes. The lesions are not peculiar to the uterus but are those common to syphilis of the more frequently attacked areas of the body. Morisani[3] as a result of histologic studies of syphilitic uteri considers angiosclerosis of frequent occurrence. Findley[4] in his excellent textbook considers this subject in detail and apparently concurs in this opinion. A fibrosis of the uterine musculature accompanies the blood-vessel changes.

Gummata of the uterus may be single or multiple and vary considerably in size, but are usually moderate in dimension, and differ in no respect from similar lesions arising elsewhere in the body. A student of the literature pertaining to the pathology of syphilis of the uterus cannot fail to be impressed with the paucity of well authenticated cases and with the fact that as yet our knowledge of this subject is far from complete. From a clinical standpoint the question of so-called syphilitic uterine hæmorrhages is of perhaps the greatest interest. The common practice of attributing symptoms which clear up under antisyphilitic treatment in patients exhibiting a positive Wassermann test to a syphilitic origin is at least open to scientific doubt. Probably the bleeding in many of these cases is properly attributed to syphilis, but on the other hand, with a disease as frequent as syphilis and taking into consideration the numerous and often obscure non-syphilitic conditions which cause hæmorrhage, it is but reasonable to assume that combination of these may occur and the hæmorrhage be in some instances due to a condition totally apart from specific origin. The writer believes that this is a fertile field for further investigation. With the increasing facilities with which the spirochæta pallida may be demonstrated and the fact that curettage is a frequent and in many cases a justifiable method of treatment of uterine hæmorrhages of obscure origin it would seem not a difficult procedure to work up a series of cases from which a definite basis of histologic study could be made. If, for example, a series of specimens in which the spirochæta pallida was demonstrated was obtained and these were then studied from a histologic basis, the results of the latter would go far to establish upon a firm basis the pathology of syphilis of these structures, and we would then be in a position to state positively whether or not certain histologic changes were sufficiently characteristic to warrant a diagnosis of syphilis or whether we should have to depend upon the demonstration of specific organism. With the possible exception of gumma it is doubtful whether a histologic verification is sufficient.

The German views pertaining to this subject are well expressed by Meyer.[5] He states

[1] Franceschini, G. Gazz. d. osp., Milano, 1909, xxx, 537.

[2] Franceschini, G. Gazz. d. osp., Milano, 1909, xxx, 537. Chiarleoni, quoted by Gellhorn, G., and Ehrenfest, H. Tr. Am. Gynec. Soc., 1916; Rille, quoted by Gellhorn and Erhenfest, ibid. Fasola, ibid; Spinelli, ibid; Morisani, T. Arch. di ostet. e ginec., Napoli. 1901, viii 27; La Torre, ibid.

[3] Morisani, T. Arch. di ostet. e ginec., Napoli, 1901, viii, 27.

[4] Findley, P. Diseases of Women. Philadelphia: 1913, p. 32 (contains an extensive bibliography).

[5] Meyer, P. Deutsch. med. Wchnschr., 1913, xxxix, 169.

that very little is known about the syphilitic inflammation of the uterus, but that Doederlein,[1] Weber, and others are of the opinion that there is no characteristic change in the uterine mucosa which can with certainty be described as syphilitic.

SYMPTOMS

These naturally vary with the character of the lesion. With the present unsatisfactory status of the pathologic changes produced, the symptomatology is necessarily uncertain. Undoubtedly hæmorrhage is the symptom which has attracted the most attention. We have already mentioned the fact that hæmorrhage is frequently attributed to a syphilitic origin without convincing proof. Hæmorrhage is by no means a constant symptom in endometritis or metritis in general, although variation and menstruation are of frequent occurrence. In such conditions the ovaries are usually more or less involved in the inflammatory process and whether or not the menstrual irregulation occurring in these cases is the result of the uterine or the ovarian involvement is open to doubt. This naturally opens the entire and much debated cause of such hæmorrhages. Time will not permit a discussion of this subject, it suffices to say that the author is of the opinion that inflammation in either the ovary or the uterus may, under certain circumstances, result in menstrual irregularity, but that in the majority of cases the ovary is the governing factor.

The most frequent form of hæmorrhage described is menorrhagia. In 1906 Dreyer[2] collected from the literature fourteen cases of hæmorrhages attributed to uterine syphilis. A year later Muratow[3] called attention to the fact that syphilitic hæmorrhage from the uterus is not so rare as we might think, and as evidence of this he mentions the cases of hæmorrhage which do not respond to the ordinary styptics and curettage, but do well under specific treatment. He points out that in such cases the uterus may be neither enlarged nor painful, but is firm in consistency and the cervix often hyperæmic. Hæmorrhages in young girls Muratow[4] believes are frequently due to a latent form of hereditary syphilis. In 1909 Falk[5] demonstrated before the Berlin Obstetrical Society a case of luetic ulcer of the portio associated with syphilitic metrorrhagia, which disappeared under specific treatment. Recasens[6] reported six cases of syphilitic metritis, five of which were cured by treatment, but in the sixth case carcinoma of the fundus was suspected and a hysterectomy was performed, but upon microscopic examination no cancer was found. Meirowsky and Frankenstein[7] have described three cases of tertiary syphilis in which amenorrhœa persisted for 6 years in two cases and for 8 years in the third. In two of these the menses returned after the exhibition of specific treatment and the third menstruated vicariously through the nose after treatment was instituted. These authors attribute the amenorrhœa to either constitutional causes such as often produce amenorrhœa in subjects of pulmonary tuberculosis or to a syphilitic oophoritis.

McIlroy, Watson and McIlroy[8] applied the Wassermann test to one hundred gynecological patients in only six of whom was there a clinical history of syphilis.

The test was positive, however, in forty-three cases, negative in forty-eight, while in the remaining nine cases it was doubtful. They state that their results show that cases in which uterine hæmorrhage apart from tumor is the principal feature, syphilis very frequently is present. They are also in accord with Muratow (cited above) in the belief that some of the cases of menarchial hæmorrhage are of syphilitic origin. Further work along this line has been done by Whitehouse.[9] He studied sixteen patients with a clinical diagnosis of chronic metritis and subjected them to a Wassermann test. Only one patient furnished a history of lues. All of the others strongly denied such a

[1] Doederlein. Veit's Handbuch der Gynaek. Weisbaden: 1907.
[2] Dreyer, A. Dermat. Ztsch., Berl., 1906, xiii, 537.
[3] Muratow, A. A. Zentralb. f. Gynaek., Leipzig, 1907, xxxi, 830.
[4] Muratow. Ibid.
[5] Falk. Tr. Berl. Obst. Soc., 1909.
[6] Recasens, S. Ann. d. Acad. de obst. (etc.), Madrid, 1911, iv, 105.
[7] Meirowsky and Frankenstein: Deutsch. med. Wchnschr., 1910, xxxvi, 1444.
[8] McIlroy, A. L., Watson, H. F., and McIlroy, J. H. Brit. M. J., 1912, p. 1002.
[9] Whitehouse, B. J. Obst. and Gynæc. Brit. Emp., 1914, xxv, 13.

possibility and there was no reason to doubt them. In spite of this, however, seven cases gave a well-marked positive reaction. These patients all applied for treatment on account of pelvic pain, irregular and profuse uterine hæmorrhage and watery or mucopurulent discharge.

The physical signs obtained upon bimanual examination were those usually regarded as characteristic of chronic metritis; namely, a slight but uniformly enlarged uterus, firm in consistence, and tender upon palpation. The specimens removed from these cases show well marked fibrosis and peri- and endarteritis. Whitehouse believes that a true gumma does not occur in the corpus uteri. He also calls attention to the fact that although pyometra is usually attributed to malignant disease, he has observed two cases and records two others from the practice of another physician in which pyometra occurred in patients with well-marked tertiary lesions and no evidence microscopically or macroscopically of malignant disease. He has never been able to demonstrate the spirochæta pallida either in sections of the uterus or in the menstrual blood but is impressed with the necessity of testing by the Wassermann reaction all patients who present the clinical picture of chronic metritis or fibrosis.

As in all inflammation involving the endometrium and myometrium leucorrhœa is a not infrequent symptom. Various types of leucorrhœa have been described. Neumann[1] believes that the discharge is usually thin and moderately profuse. Pain, dyspareunia, and other symptoms common to non-syphilitic metritis have been noted. As a matter of fact none of the local subjective symptoms are by any means characteristic of syphilis. The following is the report of a case of probable syphilis of the uterus.

Age 36 years; white; married; 3 children; 3 miscarriages. Family history, negative. Chief symptom, menorrhagia.

Previous history. Until the past five years has been a strong healthy woman. Married at 24 years. Three children, 10, 8 and 7 years, healthy and strong. Six years ago the husband contracted syphilis and upon the development of the secondaries was placed upon treatment by his family physician. At about this time he undoubtedly infected his wife. She, however, gives no history of a primary sore, but the development of typical secondaries and their disappearance under treatment established the diagnosis. During the past six years or since the onset of her syphilis the patient has had three miscarriages, advanced respectively 2, 3, and 5 months; the last of these six months ago. The patient has been treated by her family physician for syphilis until nine months ago (mixed treatment), when treatment was discontinued by the patient as she believed herself cured. Until coming to the University Hospital no Wassermann tests or attempt to demonstrate spirochæta pallida had been made.

Present illness. A five months' miscarriage occurred six months ago; one month later menorrhagia developed. Instead of the periods as formerly lasting 4 to 5 days, they now last 8, 10, or 12 days. The bleeding is for the first 6 to 12 hours moderate in amount, but by the second day is profuse, bright red, and takes on the character of a severe hæmorrhage. This continues for a varying period of time and gradually diminishes, a moderate mild flow continuing and lasting for a week or more. As a result of the last three bleedings, despite the usual treatment, such as rest in bed, ice, ergot, etc., so much blood was lost that the patient has been much weakened. When brought to the hospital the patient had been bleeding for 12 days. For the last three periods patient has been bedridden during and for some time following the flow. Between periods and especially during the days immediately following the cessation of the bleeding there has been a profuse, thin, non-odorous leucorrhœa. Dizziness, weakness, headaches, and other evidences of anæmia have been present. All these symptoms are worse toward the end of and immediately following the flow. There has been no pain. The appetite is variable and the bowels at times constipated.

Physician's examination. This reveals a moderately well-nourished woman. The heart, lungs, liver, and kidneys are normal. Blood, hæmoglobin 52; red blood-corpuscles, 5,000,000; white blood-corpuscles, 4500. Wassermann strongly positive.

Abdominal examination, negative.

Pelvic examination, negative. Outlet multiparous. Good support in anterior and posterior wall, cervix normal in size and shows a well healed bilateral laceration. It is softer than normal and the canal is patulous, slightly dilated, just admitting the tip of the finger. The uterus is normal in size, shape, and position. It is movable and not unduly tender even on deep palpation. The adnexæ are normal. A careful examination fails to reveal any evidence of the site of the primary sore.

Owing to the lack of any assignable cause for the hæmorrhage, a diagnostic curettage was advised.

Operation. On moderate traction with a tenaculum during an effort to draw down the cervix the instrument tore through the cervical tissue. During the curettage with a Martin curette the fundus was

[1] Neumann, Isidor. Syphilis. Vienna: 1896.

perforated. No undue force had been used. In view of the evident softness of the uterus, the fact that a perforation was present in the fundus, the history of severe and persistent bleeding, the age of the patient, and the fact that she already had three living children, a hysterectomy was decided upon and performed in the usual manner. The tubes and ovaries were not removed.

Convalescence was normal. The patient was placed upon a tonic and one administration of salvarsan was given intravenously before leaving the hospital and her family doctor advised as to the condition so that antisyphilitic treatment could be continued.

Pathologic description. The specimen consists of curettage and uterus.

Curettings. These consist of a moderate amount of macroscopically normal endometrium.

Uterus. This has been removed by supravaginal amputation. It is normal in size and shape, measuring 7.5 centimeters from the point of amputation to the top of the fundus, 6 centimeters laterally and 5 centimeters anteroposteriorly (through fundus). The endometrial cavity presents no abnormalities; an incomplete curettage has been performed. It measures 5.5 centimeters in depth. The myometrium is normal in thickness and is rather paler than normal, cuts with ease, and in the vascular layer large numbers of blood-vessels are present, the cut ends of which are remarkably prominent. These and the friability of the tissue are the chief peculiarities of the specimen. The myometrium is so soft that the walls may be squeezed through with ease at any point with the thumb and forefinger. In the posterior wall of the fundus is a perforation which will admit a small lead pencil.

Histologic description. Endometrium. The endometrium is normal in depth or perhaps slightly thickened. The surface is fairly smooth and is covered with a single layer of high columnar cells. The superficial layers of the stroma are infiltrated with blood, serum, and chronic inflammatory products. At some points subepithelial hæmorrhages are present. In one of these the surface epithelium has been desquamated. The deeper portions of the stroma are condensed and fibrous. Many blood-vessels are observed. The majority of these possess well-developed muscular walls in which marked sclerosis is present. Scattered here and there are areas of chronic inflammatory reaction. The line of demarcation between the mucosa and underlying muscularis is well defined. The glands are normal in number, size, and shape and are of the interval type. The specimen thus resembles an endometrium the seat of a chronic diffuse inflammation with marked angiosclerosis.

Myometrium. Four sections taken from various portions of the uterus. All present the same general histologic character. Immediately beneath the endometrium there is an ill-defined zone of chronic inflammatory reaction which gradually fades into the deeper and uninflamed myometrium. The blood-vessels are more numerous than normal and possess unusually thick walls. This is more marked in the media. The arteries and veins are both affected, but the changes are more pronounced in the former. In some instances the blood-vessels are six or seven times the normal size and in some the degenerative changes involve not only the vessel walls but also the adjacent myometrium, periarthritis. In one or two areas thrombi are present, while in a few fields vessels are observed in which, as a result of endarteritis, complete obliteration of the lumen has occurred. In many areas extravasations of free blood are present. The lympathic spaces are dilated. The fibrous and muscular tissue stain poorly in the eosin and hæmatoxylin preparations. Much free serum is present as a result. In some areas the muscle-fibers can be seen partially separated. In some fields these œdematous areas are more marked than in others but are quite as numerous in the fundus as in the lower portion of the uterine body. The chief histologic characteristics in this specimen are the angiosclerosis affecting chiefly the inner coats of the vessels, and the areas of œdema above described. Section fixed in Zenker's and in 4 per cent formalin solution and stained in hæmatoxylin and eosin, Weigert's fibrin stain and Van Gieson's stain.

Diagnosis. Syphilis of the uterus.

The histologic picture present in this specimen conforms closely to that described by other authors. Whether or not syphilis produces sufficiently characteristic lesions in the uterus to warrant a positive diagnosis has already been considered. In this case the changes were typical of those produced by syphilis elsewhere in the body and I have little doubt as to the correctness of the diagnosis. The histologic picture is not that of a subinvolution nor does it at all resemble those cases which are usually classified as fibrosis of the uterus. Furthermore the results of histologic examination is confirmed by the history and clinical findings. This patient contracted syphilis six years ago, anti-syphilitic treatment was discontinued nine months ago. Menorrhagia and other symptoms of syphilis of the body of the uterus developed three months later. The Wassermann test was at this time strongly positive. Whereas on account of the rarity of syphilis of the uterus, all cases of the metritic variety in which the spirochæta pallida are not demonstrated should be viewed with doubt, there nevertheless seems little question as to the correctness of the above diagnosis.

Undoubtedly the chief clinical symptom was the menorrhagia and the chief pathologic lesion the great softening and friability of the uterus together with the more typical changes usually produced by syphilis. Marked softening of the uterus has been noted by a number of observers, but is by no means characteristic of this variety of infection. Weber,[1] Bolt and others have recorded cases in which softening was a marked feature.

[1] Quoted by Meyer, Ztschr. f. Geburtsh. u. Gynaek., 1908, lxii, 640; Freund, quoted by Gellhorn, G., and Ehrenfest, H., Tr. Am. Gynec. Soc., Washington, 1916.

SYPHILITIC FEVER

In Relation to Gynecological and Obstetrical Practices[1]

By FRED J. TAUSSIG, M.D., F.A.C.S., St. Louis

TO judge by the almost complete absence of reports concerning syphilitic fever in gynecological and obstetrical literature, it is manifest that this interesting, and at times important, symptom has received no consideration by our confreres. The extensive work of Gellhorn and Ehrenfest has shown that syphilis of the internal genitals is not as rare as some of us had previously supposed. My own more limited review of a series of cases in private and clinical experience, together with an analysis of the existing literature, has convinced me that syphilitic fever is also not such a unique symptom, if only we would be constantly on the watch to analyze the possible factors in the cases of unexplainable fever that we so frequently observe.

The diagnosis of syphilitic fever can rarely be made with absolute certainty. There is nothing characteristic about the temperature curve. In the milder more common forms the fever does not rise over 100 to 100.5,° with a relatively slow pulse, and lasts only a few days; in the severer type we have a remittent prolonged fever extending for weeks or even months with an evening rise of temperature to 102 to 103° and intervals of a few days at a time when the fever almost ceases. The mass of evidence concerning syphilitic fever, doubtful as it may be in the individual case, leaves no question that syphilis is at times actually responsible for the rise in temperature. Nevertheless, in analyzing symptoms we should constantly bear in mind Virchow's warning not to call everything syphilis that appears in a syphilitic person or that disappears under antisyphilitic treatment. Thus, we can explain fever that disappears under antiluetic treatment, in four different ways:

1. The antiluetic treatment may have destroyed not only the spirochætæ, but also septic bacteria that were the cause of the fever.

2. The antiluetic treatment may have so improved the patient's bodily resistance as to enable her to overcome fever due to other organisms.

3. The antiluetic treatment may have been merely coincident with a fall of temperature due to other causes.

4. The antiluetic treatment may actually have been responsible for the cessation of a fever due to syphilis.

On the other hand, we cannot conclude that a fever is not syphilitic because it ceases without antiluetic treatment, since we know that syphilis and all its manifestations are to a certain degree limited by the natural immunity acquired by the individual. Nor can we conclude that a fever is not syphilitic because it persists in spite of antiluetic treatment, since we know that certain cases of malignant syphilis will resist all known measures.

Scientific proof of syphilitic fever in any case would require the exclusion of all other possible causes, the finding of spirochæte pallida in the blood before treatment and the

[1] Read before the American Gynecological Association, Washington, May, 1916.

simultaneous disappearance of spirochæta and fever under the customary treatment. These conditions it will of course for technical reasons be impossible to fill in more than a very few cases. In the main we must arrive at our diagnosis, possible or probable, by a careful estimation of the patient's history, physical conditions, Wassermann reaction, and the effect of *the treatment.*

Syphilitic fever may be divided into: (A) secondary syphilitic fever; (B) late secondary syphilitic fever; (C) tertiary syphilitic fever.

A. *Secondary syphilitic fever* is that which we find preceding or coincident with the outbreak of the syphilitic rash. Fournier states that it occurs in about 20 per cent of all syphilitics. The rise is not over one or two degrees, and the duration three to four days, so that the patient ordinarily gives it no attention. At the outbreak of secondaries women often come to the gynecologist either because of local sores or on account of a complicating gonorrhœa or pregnancy. It would be well therefore for us to bear in mind that a slight rise in temperature at this time has no special significance. Whether it is individual predisposition or a virulent infection that is responsible for the occurence of fever in one out of every five syphilitics at the time of the rash, it is impossible to say. Occasionally we find that the fever is quite high and persistent. An illustration of this sort occuring in an obstetrical patient was noted in the following case, the data of which were kindly given me by Dr. Ehrenfest.

Mrs. —, 29 years old, married February 1, 1915, in good health, began on April 15 to have a peculiar intermittent fever, diagnosed by her family physician as typhoid, that lasted for six weeks. Shortly thereafter she was seen by Dr. Ehrenfest, who found a faint secondary skin rash still visible and a suspicious sore on the labium minus. Widal reaction was negative and no other explanation for her fever could be found. Both the patient and her husband had a Wassermann 4+. The patient was thin and anæmic and at this time was three months pregnant. Under salvarsan and mercury a marked improvement of her general condition and increase in weight occurred.

The following important additional data were obtained from Dr. C. Foulkrod, of Philadelphia, under whose care the patient was confined in January 19, 1916.

Owing to a nephritis and the generally weakened condition of the patient, no antiluetic treatment was given just previous to and after her confinement. From January 19, to February 7, the patient had a remittent fever that varied between 99 to 102.6,° averaging a little over 101° every evening. There was no evidence of any form of puerperal or other infection. Breasts, perineum, lochia were all normal. Finally, in view of the persistent fever, it was decided to give another dose of salvarsan. On that day the temperature rose sharply from 100.4° at 3 p.m. to 104.8° at 4 p. m., falling to 101.2° at 6 p.m. and 99.4° at 9 p.m. The following day there was still a rise to 101.4°, but from February 9 on, the temperature did not rise over 99°.

The sudden temporary rise after salvarsan has been noted by other writers (Polano, Glaser). This additional occurrence of elevated temperature is clearly to be grouped as *late secondary syphilitic fever.*

B. *Late secondary syphilitic fever* offers greater diagnostic difficulties and is less frequent than that coincident with the eruption. Graves has emphasized the occasional recurrence of short periods of elevation of temperature associated with other so-called constitutional symptoms in syphilitics for some months after the onset of the disease. He interprets such symptoms as due to the occasional outbreak of organisms accumulating in a latent syphilitic person. In such as are susceptible to elevations of temperature we may have at these times a short period of fever.

Every now and then this late secondary fever will be more persistent and have a higher range of temperature. A characteristic example of this group was reported by me six years ago.[1] A brief summary may be of interest in this connection.

C. W., 23 years old, contracted syphilis about the middle of her pregnancy. The following month a typical papular eruption, sore throat, and adenitis occurred. She was put on protiodide of mercury by her physician and the eruption began to fade. Two months later I was called to see her on account of a fever starting four days previously, running up to 103.5° and without apparent cause. Typhoid, tuberculosis, pyelitis, sepsis, and appendicitis could be excluded. The persistence of fever up to 102 to 103.5° for the next ten days induced me to decide on premature labor with the hope of clearing up the diagnosis. Delivery of a living four and one-half pound child was accomplished

[1] Surg., Gynec. & Obstet., 1910, xi 71.

without trouble. The fever persisted for three days more without any apparent cause, rising to 104° on the second day post-partum. I finally decided on the possibility of syphilis as a factor in the fever and gave bichloride of mercury gr. 1—10 hypodermically on two successive days. The fever ceased at once and did not return.

Another less pronounced case came to my service at the City Hospital, March 23, 1916.

She was a negress who had been normally confined ten days previously. No evidence of pelvic infection or other inflammatory disease elsewhere in her body could be determined. Her skin still showed typical papular syphilitic spots that had appeared several weeks previously. There were enlarged post-cervical and inguinal glands. The Wassermann was negative. During the first six days she ran a somewhat irregular fever with a maximum of 102°. She was then given two hypodermics of mercury benzoate on alternate days. The fever promptly ceased and did not return during the following two weeks, at which time she left the institution. In spite of the negative Wassermann, I think we should strongly suspect syphilis as the cause of the fever in this patient.

Leblond also reports a case that belongs under this head.

The patient had contracted syphilis during her pregnancy. Under antiluetic treatment the syphilitic manifestations disappeared. Fœtal movements ceased at the sixth month of pregnancy. No treatment was given for the following five weeks. Then a 7½ months dead fœtus was spontaneously expelled. There were no abrasions in the genital tract. There was no fever for the first seven days post-partum. Without any local symptoms or explanation elsewhere in her body, the patient began to have a high remittent fever with slow pulse, good appetite, and complete absence of pain or discomfort. Antiluetic treatment resulted in prompt and permanent cessation of fever.

C. *Tertiary syphilitic fever* is much less frequent than the secondary types, but is of greater diagnostic importance. The fever is usually continuous and attended with an elevation of temperature of 102 to 103°. Evidences of the syphilitic infection are usually absent and the symptoms have been forgotten by the patient. The diagnosis is therefore established with great difficulty and usually after considerable delay. To the 62 reasonably certain cases tabulated by Stern in 1912, I was able to add 21 additional cases, including one of my own, making a total of 83 cases. The organs primarily affected by the tertiary process in these cases were:

Liver	29
Bones and joints	19
Lungs and air passages	11
Nervous system	6
Spleen	4
Circulatory system	3
Hereditary	3
Female genitalia	1
Uncertain	7

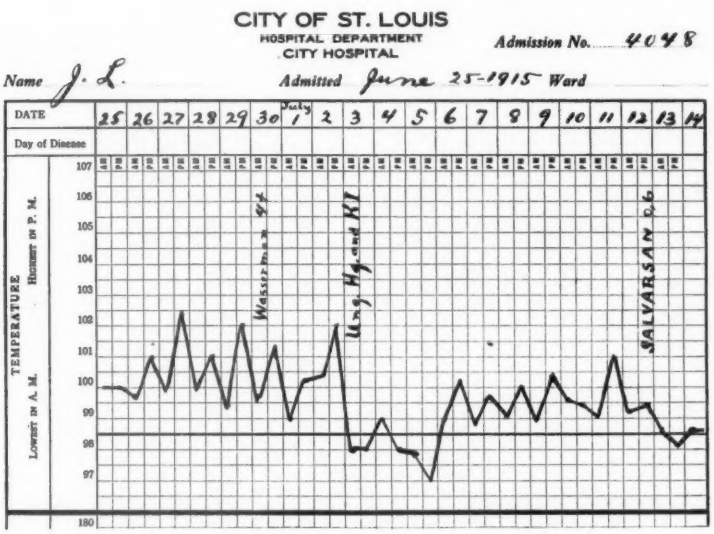
The gummatous lesions upon the skin, as well as those occuring so frequently about the external genitals of women and in the rectum, do not apparently give rise to this tertiary syphilitic fever. Occasional slight elevations of temperature such as we find are more probably due to secondary infection of the ulcer. It is the deep-seated gumma such as we find in the liver and the osseous system that is most apt to give rise to this symptom. Not merely the extent of the syphilitic infiltration, however, is to be held responsible. Glaser, for example, reports a case of syphilis of the lung with complete consolidation of one lung, but with a normal temperature. Extensive liver infiltrations occur without fever; in fact, the absence of fever has been emphasized in differential diagnosis as pointing to syphilis. These exceptional cases of tertiary syphilitic fever must therefore be carefully kept in mind. Abdominal surgeons have at times mistaken the fever and liver enlargement in liver syphilis for a cholecystitis. Riedel reports having made this mistake five times.

In our special field, tertiary syphilitic fever may be subdivided into—

1. Cases in which tertiary syphilis of the genital tract caused the fever.

2. Cases in which a gynecologic or obstetrical condition was complicated by tertiary syphilis in other organs producing fever.

The interesting cases of uterine syphilis reported by Gellhorn and Ehrenfest were in part attended by tertiary gummatous infiltration of the neighboring connective tissue. I had occasion to examine most of these patients personally and some were for a time in my service at the City Hospital. In going over the temperature charts of three of these cases, those in which there was the most pronounced gummatous infiltration of uterus and parametrium, I found that all


CITY OF ST. LOUIS
HOSPITAL DEPARTMENT
CITY HOSPITAL
Admission No. 4048
Name J. L.
Admitted June 25-1915 Ward
DATE 25 26 27 28 29 30 July 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Day of Disease
TEMPERATURE
Highest on P. M.
Lowest on A. M.
107 106 105 104 103 102 101 100 99 98 97 180
Wassermann 4+
Ung. Hg. and KI
SALVARSAN 0.6

three ran a temperature on admission that could not readily be explained except on the basis of their syphilis. In observation X (B. L. 7307–13) the admission temperature was 101°, but the subsequent records are missing. In observation VI (M. B. 10612–16) at the time of admission in November, 1915, when the cervical lesion was comparatively small, the temperature went up to 99.5 to 100° for 4 days after admission. On her second admission in January, 1916, the cervix and surrounding parametrium were converted into a nodular mass such as I had never seen except in carcinoma. Only the histologic picture could convince me that this mass was really a gummatous infiltration. This woman ran an irregular fever ranging from 101° to 103.8° in the evening. While there is no denying that the ulcer was secondarily infected, the syphilitic process was essentially the cause of her death; and in view of the malignancy of the condition, and the absence of any particular symptoms from the secondary infection, the probability is that the fever was due, at least in part, to syphilis.

I should draw a similar conclusion from the data at hand concerning the case of malignant syphilis of the uterus reported by Hoffmann. Hoffmann speaks of the case as one of chronic sepsis following childbirth. The colon bacillus was, to be sure, found in the blood culture; nevertheless, autopsy findings revealed, not the picture of a severe colon infection, but that of extensive gummatous infiltrations in the uterus, right tube and ovary, retroperitoneal glands, lung, and liver. I think the question may fairly be raised whether the fever in this case was not due to spirochæte-sepsis.

Turning now from these merely suspicious cases of tertiary syphilitic fever we come to one concerning which there can be little doubt as to the correct interpretation. It was reported as observation XV (Gellhorn and Ehrenfest):

J. L. (Admission No. 4048–15), colored, twenty-eight years old. No miscarriages. One normal confinement ten years previously. Entered hospital because of a blood-tinged vaginal discharge, with pains in the right lower abdomen. Examination revealed œdema of both labia majora and minora, with a small typical tertiary ulcer under the right labium minus and an indurated urethral tube. Cervix encased in an infiltration extending to the pelvic wall. Wassermann 4+. There was no hyperleukocytosis nor any high fever such as you would expect with a large acute pelvic exudate due to septic infection. The bedside notes attached to the history shows, however, that there was a rise of temperature and, moreover, one that reacted so distinctly to the antisyphilitic treatment that

there can be no reasonable doubt of the diagnosis: *tertiary syphilitic fever*. The exact description of the changes wrought by the treatment upon the pelvic mass are equally convincing and are mutually corroborative of the nature of the affection.[1]

The accompanying temperature-curve is very instructive. The temperature ranged from 100° to 102.4° from June 25, the day of admission, to July 3, the day that the patient was first put on unguentum hydrargyri and increasing doses of potassium iodide. The temperature fell to normal for a few days and then began again to become elevated, though not as high as before. Immediately subsequent to the injection of 0.6 salvarsan the fever ceased completely and did not return.

Cases in which a gynecological or obstetrical condition is complicated by tertiary syphilis in other organs producing fever, are occasionally to be found. Two such cases have been recently reported by Glaser. One patient, the wife of a contractor, developed an intermittent high fever following confinement. There was a swelling of both liver and spleen, but no indication of pelvic infection. Malaria, septicæmia, and typhoid could be excluded bacteriologically. The husband acknowledged syphilis. In spite of a negative Wassermann, salvarsan was given, with sudden and complete cessation of fever and a disappearance of the enlargement of the liver and spleen.

The other case developed a persistent fever after a hysterectomy. No cause for this was apparent. A secondary laparotomy threw no light on the subject. Pains in the lower limbs suggested a luetic periostitis. Wassermann reaction was found to be 4+. Antiluetic treatment brought immediate cessation of fever, a gain of 18 pounds in weight, and disappearance of the bone symptoms.

Such cases should put us on our guard in every case of obscure, persistent fever, complicating a pelvic condition, to have a Wassermann reaction made and to try the effect of antiluetic treatment.

CAUSE

The cause of syphilitic fever has been the subject of considerable debate. Some insist that we must explain it on the basis of a secondary infection with other bacteria (Rosenthal, Kirckheim), but the majority feel that the evidence at hand justifies positively the conclusion that the fever is due to the spirochætæ and their toxins. Sobernheim considers it possible that the rise of temperature is due merely to the absorption of products of tissue-necrosis and is therefore independent of the organism itself. If this were true, however, we should not expect so immediate an effect upon the temperature from antisyphilitic treatment, but rather a gradual cessation of fever. Schleglmann and others believe that when syphilis attacks the liver, we are more apt to have fever, since interference with the metabolism of that organ causes elevations of temperature. In this connection, Stern points out the frequent association of fever in the secondary stage of syphilis with a mild degree of icterus indicative of interference with liver function. Monier and Fournier believe syphilitic fever is more frequent in women than in men, but this statement has not been sufficiently confirmed. The most plausible explanation why some have fever and others do not is that put forward by Stern. In syphilitics without fever it is possible that only the spirochætæ enter the circulation, while in those having fever the spirochætæ plus their toxines get into the blood and it is the latter that produce the rise in temperature.

Additional information as to the cause of syphilitic fever may come out of our study of the rise of temperature that is occasionally seen after injections of mercury or salvarsan. Polano found in 12 out of 106 cases of secondary lues a temporary elevation of one or two degrees after mercurial injections. Gron reports a similar occurrence in 10 out of 100 cases. Glaser found that such a rise of temperature after salvarsan or mercury injections given with the utmost precautions occurred with greater frequency in latent lues. He explains the symptom as due to the death of larger numbers of spirochætæ. The resultant liberation of their endotoxines causes sufficient irritation to produce a moderate degree of fever. Bauer also found a rise of temperature after the first injections in liver syphilis.

[1] For a detailed history and description of the physical examination I would refer the reader to the article by Gellhorn and Ehrenfest on "Syphilis of the Internal Genital Organs" in the *Referat on Syphilis*, American Gynecological Society, p. 232.

To summarize then:

1. The diagnosis of syphilitic fever can rarely be made with absolute certainty, but we should more often consider it as a possibility, and institute antiluetic measures in suitable cases.

2. Secondary syphilitic fever occurs in a mild form in 20 per cent of patients at the outbreak of the rash and at times is prolonged and more severe in its course.

3. Late secondary syphilitic fever is occasionally seen in a pronounced form after confinement or in gynecological patients.

4. Tertiary syphilitic fever is practically never due to syphilitic lesions in the female genital tract. One such case is reported by the author. It may however complicate a gynecological or obstetrical condition and, owing to the difficulty in locating the site of the tertiary lesion, lead to a wrong diagnosis as to the cause of the fever. All doubtful cases should be subjected to a Wassermann test and, if positive, given antiluetic treatment.

5. Syphilitic fever is probably due to the reaction of the body to the toxines produced by the spirochætæ which under certain circumstances or in certain individuals gain an entrance into the circulation.

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OBSERVATIONS ON THE OCCURRENCE OF SYPHILIS IN THE UNIVERSITY OF MICHIGAN OBSTETRIC AND GYNECOLOGIC CLINIC[1]

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FORTUNATELY due to the thorough and exhaustive work of the referenten the participants in this symposium on syphilis in its relations to obstetric and gynecologic practice can omit introductions and references to the literature and confine themselves strictly to their portions of the discussion.

It is only within the past five years, since the discovery of the spirochæta and the Wassermann reaction, that syphilis can be said to have been studied with any degree of scientific accuracy in the obstetric and gynecologic clinic in the University of Michigan Hospital. Active cases of syphilis with abundant skin or mucous membrane manifestations were recognized and the proper treatment instituted, but we were quite ignorant as to the extent of latent lues with the result that many cases passed unrecognized and the patients suffered accordingly. While the system carried out in the University Hospital for the recognition and treatment of syphilis is not without its faults and no doubt could be greatly improved upon, it has served its purpose as a beginning and is vastly superior to no system at all.

For the past year there has been a hospital rule that every in-patient should have a Wassermann taken, and, while the rule has not for various reasons been so strictly adhered to as could be wished, its value is gradually becoming realized so that more and more of such examinations are being made from each clinic. At the present time the hospital serological laboratory is making something like five or six hundred Wassermanns a month; and as the serological records are most accurately kept, data is accumulating from which most valuable conclusions can be drawn.

It is the unwritten rule of the Hospital that all cases of syphilis be referred, not transferred, to the Department of Syphilology for examination, advice, or treatment. This is a most fortunate custom, for each case is thus seen by an expert on the disease in question and an authoritative diagnosis is secured. In the same way the treatment is not haphazard as may be the case when not carried out by a specialist. If the report which is to follow can be considered of any value, it will largely be due to the accurate and careful work of the serological laboratory and the scientific nature of the work emanating from the Department of Syphilology, of which Professor Udo J. Wile is chief and to whom I tender my grateful appreciation.

It will remain for others to point out when and how the Wassermann reaction may fail as a test for lues. Undoubtedly it does fail in a negative way since it is fully recognized that an individual may have the disease and not show the reaction. Yet the test is of undoubted value when positive and if carried out in a series of cases is a fair indication of the frequency of the disease, especially if the doubtful cases be checked up by the examinations of an expert.

[1] Read before the American Gynecological Society, Washington, May 9, 1916.

First, as to the frequency of syphilis in a general hospital as revealed by the Wassermann examination. The results in 2,000 cases have been tabulated excluding patients admitted to the Department of Dermatology and the Departments of Syphilology and Neurology, since the inclusion of the large number of syphilitics in these two services would have interfered with the purpose of the investigation, which was to ascertain the frequency of syphilis in average hospital patients.

In 2,000 patients there were 110 distinctly positive Wassermanns in which the diagnosis in almost every instance was confirmed by the Department of Syphilology. Among the doubtful reactions there were 8 in which the patients were afterward proved to be syphilitic. This shows that practically 6 per cent of the general run of hospital patients are syphilitic. Making allowance for the possibility that some luetics may have given negative reactions and that re-examination of the doubtful cases might have given some positives, it is fair to assume that from 6 to 8 per cent of the patients in this particular hospital, excluding certain clinics, were syphilitic.

The percentages varied in the different series as can be seen by the following:

	Per cent
Obstetrics and gynecology	4.8
Medicine	4.7
Ophthalmology	8.7
Otolaryngology	5.0
General surgery, orthopedics and genito-urinary	4.1
Pediatrics	11.0

The proportion of syphilitics in this hospital material is on the whole rather low. Subsequent reports may show decidedly higher figures more in agreement with those from other hospitals. Possibly the nature of the hospital material accounts in some measure for the low percentage of syphilis, since the patients are mostly from the country districts. Be that as it may the figures are presented for consideration as a contribution to the subject under discussion.

SYPHILIS IN THE OBSTETRIC CLINIC

There were 18 undoubted cases of lues in the 381 obstetric patients examined, or 4.7 per cent. These patients were given the Wassermann test, their histories taken with special reference to syphilis, and all positive and doubtful cases referred for diagnosis to the Department of Syphilology.

In explanation of this low percentage of syphilis among a class of patients where the ratio apparently should be high, it may be said that it is probably due to the class of patients from which the material is drawn. Although 62 per cent of the material is made up of illegitimates, the average age of the 381 patients being 23 years, as a class, the patients have not been unduly exposed to syphilis. They are country girls, waitresses, stenographers, telephone operators, very few being prostitutes or street walkers.

The laboratory reports show the varying degrees of intensity of the Wassermann reaction, its doubtful nature or its absence. Of the 18 undoubted cases of syphilis there were 12 with 4+, one with 3+, 2 with +, and 2 with ± reactions, while in one instance although a Wassermann was not obtained on the mother, the fœtus showed a 3+ Wassermann and the placenta was syphilitic.

HISTORY OF LUES AND CORRESPONDENCE WITH THE RESULTS OF WASSERMANN EXAMINATIONS.

This is an interesting field for investigation since it shows that in the majority of instances, even where particular attention is paid to the history, nothing suggestive of syphilis can be found. There was a positive history of luetic infection in 8 of the 18 cases. Of these 5 gave 4+ Wassermanns, 1 a 2+, while 2 were doubtful or ±. On the other hand, where the histories were doubtful in three cases all gave 4+ Wassermanns. In 7 cases the histories were entirely negative as to syphilitic infection but of these 4 gave 4+ reactions, 2 were 1+, while in one case the Wassermann was not obtained, the evidence of maternal syphilis being gained from an examination of the fœtus and p acenta.

PHYSICAL SIGNS OF SYPHILIS

In only 8 cases out of the 18 syphilitics were there positive signs of lues as revealed by careful physical examination. Of these 5 gave 4+ Wassermanns, 1 was 3+, while 2 were ± or doubtful. On the other hand, in four cases

where the results of the physical examination were doubtful all gave 4+ reactions. In 5 cases there was entire absence of signs of lues on careful physical examination, although in two of these cases there were 4+ positive Wassermanns in 2 reactions were+, while it was not obtained in one case.

This is additional proof of what has long been known that in women in particular there may be few or no signs of syphilis although from other information undoubtedly the disease is present.

TREATMENT DURING PREGNANCY AND ITS EFFECT

The results of treatment of the syphilitic mother and the effects of such treatment upon the child prior and subsequent to birth are of especial interest to the obstetrician.

Of the 18 luetics, 14 received treatment, 7 before and 7 after labor, while 4 patients refused treatment. The treatment consisted of varying doses of salvarsan and mercury.

There were 12 full-term labors and 6 premature deliveries among the 18 luetics. All but one of the 6 patients receiving treatment before labor carried their children to full term. Of the other 6 women going to full term although in all but two instances they gave 4+ Wassermanns the other signs pointed to old infections except in one case where infection took place at the seventh month. Of those receiving treatment with full-term labors two were conceptional infections, while the others were infected two to four years previously. Five of the six women who miscarried received no treatment before or during pregnancy. In all except a single case where the infection was old, infection occurred at the time of or very soon after conception.

This is a very good showing for the treatment of the syphilitic pregnant woman, so far as an aid in carrying her child to full term is concerned and shows that salvarsan and mercury are well borne by the syphilitic mother. Exceptions to this statement may be found in the literature but should not deter us from instituting vigorous treatment with both salvarsan and mercury in our pregnant syphilitic patients.

THE RESULTS OF WASSERMANN EXAMINATIONS ON NEWBORN INFANTS

It is a routine procedure in the obstetric clinic to collect blood from the umbilical cord in a test tube and send it immediately to the Serological Laboratory for examination. In no case where the maternal blood in the 381 cases examined gave a negative Wassermann reaction was the newborn infant's reaction positive. In fact only 3 of the children of the 18 luetic mothers gave positive Wassermann reactions at birth and these mothers received no treatment during pregnancy. Two babies whose mothers received no treatment during pregnancy, while giving negative reactions at birth, gave positive reactions later at the twelfth and fourteenth week respectively.

Thus it would seem as if treatment of the syphilitic mother during pregnancy had a favorable effect upon the child although it must not be lost sight of that the manifestations of syphilis may develop later. As it is the rule of the department that no child of a syphilitic mother with or without serological and physical manifestations of the disease shall be sent out for adoption, it will be an easy matter to ascertain the subsequent histories of the children of luetics who gave no evidence of disease when they were discharged from the maternity. This investigation on latent syphilis is now being carried on and will be reported upon later.

SYPHILIS IN THE GYNECOLOGIC CLINIC

The Wassermann test was made upon 390 gynecologic patients. Nineteen of these patients gave 4+ Wassermann reactions, one a 3+ while two others with less marked reactions were judged to be luetic, making a total of 22 patients among the number examined or a percentage of syphilitic patients of 5.6.

The average age of these 22 patients was 22 years; 16 were married and 6 were single.

A definite history of syphilis was elicited in only 5 of the 22 cases while in one case it was suggestive. In only one case was a

definite history of lues in the husband obtainable.

The above shows the great importance and value of systematic Wassermann examinations upon gynecologic patients. If such systematic examinations be not employed, local lesions may be attended to surgically and by other methods of treatment, but a far more important general disease will in many cases be overlooked and no attempt made to cure the patients. Wassermann examinations are particularly important in women since in many instances the diagnosis can only be made in this way, as the local manifestations of the disease are far less marked in women than in men. Many cases puzzling to the gynecologist in the past because of failure to be restored to health may be explained at the present time, for many of them were undoubtedly cases of latent syphilis.

The findings in the 22 luetic patients as reported by the Department of Syphilology are extremely interesting and show what a great aid is the Wassermann test in the establishment of the diagnosis.

There were 15 cases of latent syphilis, all giving 4+ or 3+ Wassermann reactions, but with few physical findings, in most cases only a slight adenopathy. Certainly such physical signs without the aid of the Wassermann test would have been apt to escape the notice of even the gynecologist most expert in general physical examination.

Another interesting feature about this group of syphilitics with gynecologic conditions was that in no patient was the diagnosis made from an inspection or palpation of the genital organs. Again in no case from the material submitted to the pathologist was the diagnosis of syphilis made by microscopic examination. Undoubtedly this would not be true of other gynecologic clinics where the lesions of recent acute syphilis predominate, but these are special clinics and do not represent average gynecologic material. It is also possible that future investigations of the material at our disposal in the light of what will be learned from the discussions at this meeting will enable us to recognize what heretofore has escaped our observation.

SUMMARY AND CONCLUSIONS

1. Only by routine Wassermann tests will the obstetrician and gynecologist best serve the interests of his patients.

2. Especially is this true in hospital practice where even careful histories fail to arouse suspicion of latent syphilis.

3. Out of 2000 in-patients in the University Hospital excluding two services the proportion of syphilitics was 6 per cent.

4. The nature of the hospital material will determine the percentage of lues, but in the average hospital the ratio will not be far from 8 to 10 per cent if the entire hospital population be included.

5. The same holds true for the proportion of syphilis in any special clinic, the percentage varying according to the nature of the material.

6. The percentage of lues in 381 cases in the University Maternity was 4.7 as shown by the Wassermann reactions and expert physical examinations.

7. In 18 cases of syphilis among the number examined only 8 gave a history of lues.

8. In only the same number (8) were there positive physical signs of lues.

9. As shown by the histories of the 18 cases there is a greater chance for the syphilitic mother treated by salvarsan and mercury to give birth to a living, full-term child than where no treatment be given during pregnancy.

10. The newborn infants of the mothers so treated do not give positive Wassermann reactions, although undoubtedly they are syphilitic and later probably will show signs of the disease.

11. A certain proportion of the newborn children of untreated syphilitic mothers will give positive Wassermanns.

12. Out of 390 gynecologic patients subjected to the Wassermann test, 22, or 5.6 per cent, gave positive reactions.

13. In only 5 of the 22 luetic patients was there a history of syphilis.

14. Hence the importance of such examinations, or a serious general disease will be overlooked and the gynecologic patient will remain uncured.

THE SPECIFICITY OF THE WASSERMANN REACTION[1]

By RUDOLPH BUHMAN, M.D., St. Louis

SINCE the introduction of the Wassermann reaction into the realm of medicine it has taken its place in the front rank of the various laboratory tests and reactions, as an aid to the clinician in clearing up many of the obscure cases with which he is confronted. It has received both praise and condemnation at the hands of these clinicians; praise if it aided them in the diagnosis of some complicated case, and condemnation if it did not coincide with the clinical findings.

The reaction is based primarily upon the Bordet-Gengou phenomenon of complement fixation; that is, the presence of an immune or antibody in the blood-serum in conjunction with the specific antigen will fix the complement. The fixation of the complement is determined by the addition of corpuscles and their amboceptors. If hæmolysis takes place the complement has not been fixed; if, however, hæmolysis does not occur the complement has been fixed. To illustrate, the serum from a typhoid fever patient in conjunction with an emulsion of typhoid organisms fixes the complement and prevents hæmolysis taking place upon the addition of corpuscles and their amboceptors.

Upon this theory Wassermann assumed that the serum from a syphilitic patient plus its antigen would likewise fix the complement. However, as the organisms were not then obtainable in pure culture, he substituted for his antigen a watery extract from tissues rich in spirochætæ. By this method he obtained a fixation of the complement when the serum of a syphilitic person was used, whereas there was no such fixation when the serum was from a normal person. It was therefore assumed that the reaction was the result of a specific antigen and antibody combination. This may have been true as Noguchi (4) has obtained fixation of the complement with the serum from some syphilitic patients, with an antigen made from an emulsion of spirochætæ in pure culture.

The specificity of the reaction, however, received a setback a short time later when it was shown by Levaditi Yamanouchi (1), Porges and Meier (2), Landsteiner, Muller, and Potzl (3), Noguchi (4), and others that alcoholic extracts of normal as well as syphilitic organs had the properties of binding the complement in the presence of serum from a syphilitic individual.

Although the true explanation of the nature of the reaction is lacking, it is known that it does not correspond in the ordinary biological sense to that between antigen and antibody as was originally believed. Subsequent work has tended to indicate that it is due to an interaction of lipoidal substances. Future work along the lines of immunochemistry may ultimately elucidate the peculiar character of the reaction. Should such be the case, however, the diagnostic value of the reaction will not thereby be increased.

From the foregoing it is obvious that the reaction is not a specific one. Now the question naturally arises, "May conditions other than syphilis give a positive reaction?" If one accepts the reports in the literature, then he must believe that almost all the diseases to which the human system is heir will give positive reactions.

Thus positive reactions have been reported in frambœsia (Bruck 5, and Hoffman and Blumenthal 6) in which the etiological organism is the spirochæta pertenius. In recurrent fever and dourine Korschun and Liebfried (7) report 50 per cent positive reactions. The organisms of these three diseases are very closely allied to the spirochæta pallida, which may account for the positive reactions in them. Eichelberger (8) reports positive reactions in 40 per cent of a series of scarlet fever cases; Jacobovis (9) 18 out of 55 cases; Weil and Braun (10) report positives in sepsis, cancer, typhoid fever, tuberculosis, and diabetes; Wechselman and Meier (11), Eitner (12), Jundell, Almkvist and Sandman (13), and others report positives in leprosy; Boehm

[1] Read before the American Gynecological Society, Washington, May, 1916.

(14), Reinhard (15), and Valerio (16) report positives in malaria; Halbstaedter, Mueller, and Reiche (17) report positives in measles, varicella, and pertussis; Treuber (18) reports positives in lymphosarcoma; Boas and Peterson (19) report 3 positives out of 60 cases of chloroform narcosis; Wolfsohn (20) and Reicher (21) report positives in veronal-morphine-scopolamine-ether narcosis; Dreyer (22) in lead poisoning; Richards (23) in diabetes with acidosis; Lassen (24) in sarcoma; Hesse (25) in 9 of 11 cases of pemphigus; Sutherland and Mitra (26) in 9 of 50 cases of malaria (3 of these were leutic), 10 out of 38 of kala-azar, 7 out of 34 cases of leprosy; Verdozzi and Urbana (27) report 8 positives out of 9 cases of cancer of the liver; Craig (28) reports that the presence of certain strains of staphylococci and streptococci will convert negative reactions into positive ones. Caan (34) reports 35 positives out of 85 cases of carcinoma; and Semon (29), Duanay (30), and Zubrycki (31) report positives in eclampsia with jaundice. Serums heavily laden with bile will occasionally prevent hæmolysis taking place without the addition of an antigen.

The above reports however must be accepted with a great deal of reservation, for the following reasons:

1. The majority of these reports date back to the infancy of the reaction.

2. The liability of error on account of the delicacy of the technique required in the performance of the reaction.

3. As our knowledge of the technique has advanced, the number of positives in diseases other than syphilis has gradually decreased.

4. Statistics of results obtained by other men, in which it is the exception that positives are obtained in diseases other than syphilis; namely: Browning and McKenzie (35), Scheidemandel (36), and MacCormac and Morson (37).

The abundance of material furnished at the Barnard Free Skin and Cancer Hospital gave me the opportunity to compare the various statistics enumerated above and to contribute to the question. The following cases were examined: 136 cases of malignant diseases, 53 cases of skin diseases, and 99 cases of miscellaneous diseases. The original Wassermann method was adhered to with two exceptions, namely the quantity of all of the reagents was reduced one-half, and the watery extract antigen was replaced with alcoholic extracts. One-half the original quantity was used, because too much blood would be necessary, since two or more antigens were used in each case.

Hæmolytic system, sheep corpuscles, their amboceptor, and complement.

Sheep blood is obtained from an abattoir, immediately defibrinated, washed not less than five times with sterile saline solution, and used within twenty-four or forty-eight hours. This plan is uniformly adhered to. The variation in the density of the suspension is then but negligible. Occasionally one will meet with cells that are unduly fragile and will therefore show some hæmolysis. This is easily determined by making up a 5 per cent suspension of the cells in normal saline solution, placing them in the refrigerator over night, and if the supernatent fluid is tinged, some hæmolysis has taken place. These are not to be used.

Amboceptor. The anti-sheep rabbit amboceptor is used. This remains fairly constant for a period of from four to eight months, if sealed in small ampules and kept constantly in the refrigerator.

Complement. Fresh guinea-pig serum is used. As there is more or less variation in the strength of the complement in different pigs, it is preferable to use the pooled blood from several healthy animals. The complement and amboceptor must be titrated for their respective units before the day's work is begun.

Antigens. It has been my custom to use three different antigens for the past two years. These are all prepared by a similar method as follows:

The tissues, fat free, are minced and placed in absolute alcohol (in the proportion of one gram of minced tissue to ten cubic centimeters of alcohol), incubated for a period of time (usually four to six weeks), with frequent agitation, then filtered and kept at room temperature. Antigen *A*, guinea pig heart;

antigen B, liver from a case of congenital lues or liver from an infant; antigen C, a cholesterin fortified human heart, prepared according to the method of Walker and Swift (32).

The antigens must be carefully titrated for their anticomplementary, hæmolytic, and antigenic properties before they are used. The guinea-pig heart and the fœtal liver antigens are not as sensitive as the cholesterin fortified one. The latter is unquestionably the most sensitive and reliable of all of the antigens.

The material investigated may be divided into three groups.

TABLE I.—SKIN DISEASES

Disease	Number of Cases	Negatives	Positives	Weakly Positives
Pityriasis rosea	8	8	None	None
Scabies	15	15	None	None
Dermatitis	5	5	None	None
Eczema	25	25	None	None
Total	53	53	None	None

In this series of skin diseases are eight cases of pityriasis rosea, which resembles very much the secondary eruption of syphilis, and frequently the clinician has to rely upon the Wassermann reaction to arrive at a correct diagnosis.

TABLE II.—MALIGNANT DISEASES

Disease	Number of Cases	Negatives	Positives	Weakly Positives
Sarcoma	12	12	None	None
Malignant adenoma	15	15	None	None
Glioma of brain	2	2	None	None
Carcinoma	107	96	9	2
Total	136	125	9	2

This table gives the very interesting result, that of 136 cases of malignant diseases only 9 were positive and two weakly positive, and 125 gave negative results. The sarcomata and carcinomata represent the various types of these diseases and in each case was the diagnosis confirmed by microscopical examination. Of the 9 positive reacting cancer cases, 6 became negative or remained only weakly positive under antiluetic treatment. The remaining 3 cases discontinued treatment or failed to return for later observation. Three of the positives were epitheliomata of the tongue, probably developing on a luetic base, as the patients gave a history of what was no doubt leukoplakia. The two cases that reacted weakly positive were carcinomata of the cervix.

TABLE III.—MISCELLANEOUS DISEASES

Disease	Number of Cases	Negative	Positives	Weakly Positives
Trichinosis	3	3	None	None
Pernicious anæmia	4	4	None	None
Hodgkin's disease	3	3	None	None
Sporotrichosis	3	3	None	None
Scarlet fever	15	15	None	None
Leprosy	6	3	3	None
Tuberculosis	35	33	2	None
Malaria	10	10	None	None
Arthritis	6	6	None	None
Meningitis	10	10	None	None
Streptococcus infection	4	4	None	None
Total	99	94	5	None

Table III shows that of 99 cases, including various diseases, 94 reacted negatively and only 5 positively. Three of the 5 positive reacting ones were leprosy of the tuberculous type. The other two were tubercular cases both of which gave a fairly definite history of lues.

INTERPRETATION OF THE REACTION

A weakly positive reaction. Anything over 50 per cent hæmolysis should not be interpreted as a syphilitic reaction, unless there is some clinical evidence of the disease or a definite history of the infection. An individual should be spared the humiliation and condemnation of being branded with this dreaded disease with no more evidence than a weakly positive reaction. On the other hand it is the duty of the physician to protect the innocent from the possibility of an infection from one who suffers from this disease. There should be co-operation between the clinician and the serologist in all such doubtful cases; repeated Wassermann reactions should be made. If these do not clear up the case, then the provocative treatment should be resorted to, preferably a dose of salvarsan or ten days or two weeks of mixed treatment, which usually has the effect of producing a stronger reaction if syphilis be present.

A strong positive reaction, except in very rare and easily differentiated cases, is definite

proof of a syphilitic infection, even in the face of no other evidence of the disease.

A negative reaction, however, is not conclusive evidence of the absence of syphilis. The reaction is always negative in the early primary infections, usually not becoming positive until the third or fourth week. According to Craig and Nichols (35) the ingestion of a large quantity of alcohol will convert a positive into a negative reaction. A case of syphilis that has been under treatment may react negatively, which is simply evidence that sufficient medication has been administered to neutralize the Wassermann body temporarily; likewise, the serum from tabetics will react negatively in something like 35 per cent of cases.

In so far as the practical value of the reaction has been established the clinician should be urged to make use of same in all obscure cases.

CONCLUSIONS

Theoretically the Wassermann reaction is not specific, practically it is highly specific.

A strong positive reaction, with proper controls and accurately titrated reagents, is conclusive evidence of syphilis.

The diagnosis of syphilis cannot be made upon a weakly positive reaction without some clinical evidence of the disease.

A negative reaction does not exclude a syphilitic infection.

Malignant diseases do not give positive reactions.

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HIGH DEGREES OF HEAT VERSUS LOW DEGREES OF HEAT IN THE TREATMENT OF CANCER OF THE UTERUS[1]

By H. J. BOLDT, M.D., F.A.C.S., New York

YOUR secretary has requested me to add a ten-minute contribution to the symposium now before your society; my part to be on high degrees of heat compared with low degrees of heat, as a palliative treatment for advanced cancer of the uterus. Inasmuch as I but recently reported the result of my observations, I can add little to that which I published in the *American Journal of Obstetrics and Diseases of Women*, January 1916, except to say that, judging from the many letters received from colleagues who have had experience, my position is amply justified, and to add that Dr. F. W. Bancroft, of New York, has verified my position by an autopsy on a patient who had been subjected to low heat, in accordance with the technique advocated by Dr. Percy.

I do not wish to be understood as detracting from the usefulness of low heat application. On the contrary, I commend it; but not as the method to be used under all conditions. It should be reserved principally for a second application, after the rapid destruction has been accomplished by high heat, and the charred eschar so caused has been thrown off; and for cases wherein the malignant process has so far advanced that the thorough application of high heat would endanger the bladder or rectum, despite great care to avoid injury. It may happen, as a secondary result, that a slough may be caused, and thus a vesical or a fæcal fistula be established. Although such fistulæ frequently close spontaneously, we know from experience, that if they do not close, how difficult it is to bring about a closure by operation.

Then, too, the danger from secondary hæmorrhage is not less with low heat than with high heat. Indeed, it is held by some to be greater when low heat is used; though to judge from my own experience, that position is untenable.

These, however, would be negligible features, if with low heat alone we could accomplish a better final result. So far there has been no evidence presented by any one who has had experience with both methods properly tried on a series of patients that showed the superiority of one over the other. It may be admitted that, now and then, heat has cured a patient although personally I have not seen such an instance.

Indeed, were I to rely solely on the report of results, I should relegate heat to the "has been" remedies and only advise radium. But we do know that with heat properly used, and applied in properly selected cases, we have a therapeutic agent that sometimes gives remarkably good palliative effects. Dr. Percy, who is the strong advocate of low heat, makes claims for it that I have been unable to substantiate. He asserts that it has a deeper penetrating ability on the tissues, and that it destroys carcinoma elements farther away from the surface to which it is applied, than high degrees of heat, and hence its potency to cure some carcinoma patients of their disease. The late Dr. Byrne, to whom the medical profession is indebted for bringing the treatment of cancer of the uterus with heat into vogue, many years ago, made similar claims for high degrees of heat; but he was unable to convince me that it was more than an excellent palliative agent. So far as I know, no proof of further efficacy has been demonstrated by Percy. On the other hand the clinching facts, as shown in Dr. Bancroft's case and in my case, in which autopsies were procured and a microscopical examination of the tissues made, are that the cancer-cells were not destroyed to any appreciable distance from the surface of application of the low heat, certainly not farther than would have been the case with the high heat application.

Dr. Charles Mayo, in discussing my paper on this subject at the last meeting of the Southern Surgical and Gynecological Society,

[1]Read before the American Gynecological Society, Washington, May, 1916.

cited in proof of the curative power of low heat, used as Percy directs, a number of instances in the Mayo clinic at Rochester of what seemed inoperable cases of uterine cancer, that subsequently became operable, adding that when the uteri in these cases were examined by the pathologist, he failed to find any evidence of malignant disease in them. I cannot, however, accept this statement as verification of the hypothesis that low heat destroys cancer-elements some distance from the surface of heat application. It can be accepted only as a personal belief, based upon clinical manifestation of the individual patient. In such a case my view would be that the patient had, in connection with the cancerous cervix, a pure inflammatory condition, either parametritis, or a local pelveoperitonitis, which caused more or less immobility of the uterus, and that as the result of the heat treatment, the near-by structures became dried out and mobility of the uterus ensued; but the cancer itself had not penetrated beyond the depth of the cauterization. Such clinical manifestations we also see with high heat. The inflammatory infiltration may subside, but the carcinomatous infiltration remains. To disprove my contention it is necessary that the operator should, when the abdomen has been opened, remove a part of the suspicious infiltrated area in the pelvis a reasonable distance away from the cervix and have it examined by a competent pathologist. If that shows cancer-nests, and the uterus becomes mobile subsequently so that a radical operation may be done, and the specimen then removed by a real *radical* operation fails to show cancer-elements, we are in a position to grant the alleged deep destruction of cancer-elements, but not until such proof has been shown.

I call attention to those instances in which recovery followed a simple extirpation of the uterus despite the presence of some parametrial infiltration, and in which, after a period of a few months a re-examination failed to show evidence of infiltration. I myself recall two such instances.

But let us pass from the theoretical and clinical test to the crucial scientific test—the test being a deduction as the result of an examination of tissue treated by low heat in the *living* body—by which we may get evidence which is beyond the possibility of deception. This test showed, beyond a scintilla of doubt, that cancer-nests were destroyed only in the cauterized area and in the area immediately in contact with the cauterized surface. Even within only one millimeter of the charred zone, apparently unaffected cancer-nests were found. Surely high heat cannot exert a less destructive action on cancer-cells.

It is far from my intent to detract anything from the credit of our colleague, Dr. Percy, but I believe that his enthusiasm has misled him, as the result of his clinical experience, to become imbued with unfounded hope.

Byrne, although not the first man to use heat as a palliative measure, was the one to bring this treatment to a fairly extensive acceptance and was equally enthusiastic, as for a time were his followers. And when I say his followers (and I am one of them), I mean those who cauterized as thoroughly as was directed by Byrne, not superficially, as I have seen done time and again, and yet called "cauterization by the Byrne method."

To speak for myself, I can say conscientiously that I obtained and am obtaining with high heat, results equally as good as those obtained by Dr. Percy, with low heat, particularly since I open the abdomen, as insisted upon by Percy. It is my belief that if Dr. Percy will use either high or low heat, according to indications, he will arrive at similar conclusions, especially if he subjects his work to a critical scientific analysis whenever opportunity presents itself. I believe that the advice of our late colleague, Dr. Pryor, to tie the internal iliacs in cases of cancer of the cervix, is also of importance as a palliative measure.

NOTES ON THE PAST, PRESENT, AND FUTURE OF GYNECOLOGY, OBSTETRICS, AND ABDOMINAL SURGERY[1]

By J. WESLEY BOVÉE, M.D., F.A.C.S., Washington

YOUR organization now holding its forty-first annual meeting is the parent American body of the part of medicine represented by gynecology, obstetrics and abdominal surgery. As a national gynecological organization it is the pioneer of the world. Composed as it is of the men most famous in America in these spheres of endeavor for the benefit of the human race, its prestige is unquestioned. To be the chosen president of it should be the laudable ambition of every earnest and scientific American worker in the specialties mentioned. It is, therefore, with no little pleasure and pride that I sincerely acknowledge the signal honor you conferred on me last year by elevating me to this important position. It is not always brilliancy that appeals to the hearts of one's confreres, as one is bound to observe in this selection. Having been for many years at least a consistent worker in and for this society, I am prompted to believe the selection was due alone to that reason. My pride surely is pardonable when we recall the names of my very illustrious predecessors. Certainly the names of J. Marion Sims, T. G. Thomas, T. A. Emmet, Barker, Goodell, Peaslee, Baldy, Davis, Williams, Kelly, and many others who are or have been Fellows in this society will stand until the end of time as great medical geniuses. Nor can I allow this opportunity to pass to pay a tribute to the parents of this society, Chadwick, Munde, and J. Taber Johnson, all of whom have been its presidents. Though death prevents our extending the hand of fellowship to the first two, the last remains to us in sterling physical and mental integrity and may honor us by his presence at this meeting. Last year on the occasion of his transfer to honorary fellowship the society signalized its affection for him and appreciation for his services to it by sending him a very handsome tribute in the form of a well prepared letter signed by each Fellow in attendance.

In a study of the history of gynecology in America one is thrilled with pride by the remarkable strength of character portrayed by the early workers. McDowell, Nathan Smith, Peaslee, the Atlees, Dunlap, and others passed triumphantly through the fiery furnace of scorn, hatred, and slander of communities, and even of their professional colleagues, in their efforts to create a legitimate position in medicine for the surgical removal of large ovarian tumors. In Reeves' memorial of Dunlap[2] he mentions the rebuffs the latter received from surgeons and even his college professor. Dunlap states, regarding his first operation, "With a great deal of labor and care I prepared a report of the case for a Cincinnati medical journal the editor of which was my old professor of Materia Medica in the Cincinnati Medical College, Dr. John B. Harrison. The editor returned the manuscript with a note explaining that his reason for not publishing it was that it would encourage an unjustifiable and murderous operation which had already been tried and condemned by the profession, both in this country and Europe." Another rebuff was from a "noted surgeon" who told him, "You ought not to be doing such things." The Atlees, in Philadelphia, were condemned as murderers and butchers for doing ovariotomy and not a surgeon in New York would defend this operation when Peaslee read his paper before the New York Academy of Medicine in 1864. Kimball, of Lowell, Massachusetts (1855), and others were struggling similarly to secure recognition for the surgical removal of large uterine fibroids by the abdominal route.

The work and ingenuity of Sims in the treatment of vesicovaginal fistulæ will ever serve as a stimulus for the disheartened, struggling against formidable agencies in various and devious avenues of study of the mysteries of the living human body and the

[1] Presidential address, Forty-first Annual Meeting of the American Gynecological Society, Washington, May 9-11, 1916.

[2] Tr. Am. Gynec. Soc., 1894, xiv, 359.

amelioration of its ailments. The work of his faithful pupil, Bozeman, in this sphere cannot but arouse admiration. Even Sims was not entirely uninfluenced by besetting disappointments and surgical failures, for he was known to have become so disheartened in his work in the South that he sold his property and arranged to embark elsewhere upon a business career. Had not the New York clothing merchant violated his contract at this juncture, most likely medicine would have been deprived of the aid of this wonderful man and the human family of the benefit of his medical researches. His prodigious mentality and great activity were again appropriated by our profession as by a providential intercession. Just why the master mind and hand of such a man cannot be spared to benefit mankind indefinitely is one of the unexplained mysteries of Nature.

The plastic work of the eldest Emmet, and the great work of Thomas, Polk, and Fordyce Barker will always be appreciated. The plastic perineal surgery of J. Collins Warren, the round ligament operations for the rectification of posterior uterine displacements, associated with the names of Dudley, Mann, Wylie Simpson, G. H. Noble, Andrews, and others remain familiar to us all. Not to refer to Hodge, Parvin, Meigs, and Oliver Wendell Holmes were to slight obstetrics with its other great geniuses.

We must recall with American pride the impetus to urinary surgery given by Kelly who popularized direct cystoscopy and ureteral and renal exploration by its aid as well as the advanced work of several Americans in the scientific treatment of urinary diseases. The work of Goffe and Baer invoked a great advance in the surgical treatment of uterine fibromata. C. P. Noble, by his careful and laborious study into the complications and degenerations of these neoplasms, rendered an invaluable service.

I have not mentioned these great men as comprising all the talent in obstetrics and gynecology, for surely later years have not stinted us, in furnishing us with wonderful skill working with precise methods and securing definite and undeniable results, but rather as honoring myself by claiming a certain relationship with those great men. Boasting of the accomplishments of our professional progenitors and fellow-workers may be pardonable.

Of the splendid work of the past, gynecology has not neglected the great subject of cancer. This disease as it affects women is almost limited to their reproductive organs. The uterus is the organ most commonly invaded by it. Probably Wrisberg and Montaggia were the first to recommend total hysterectomy for its eradication. Marshall in 1783, and Langenbeck, in 1813, were the first to perform this operation, though in their cases the uterus protruded from each patient. In 1814, Gutberlet recommended hysterectomy by a special suprapubic method. In 1822 Sauter, of Constance, first performed vaginal hysterectomy for cancer of the uterus, *in situ*. Recamier, in 1829, recommended a special plan of vaginal hysterectomy, and the following year Delpech proposed a combined abdominal and vaginal procedure. To the lover of medical history it is interesting to read the comments upon these operations made by medical writers during the next few years. Blundell, whose small book, "Observations on Some of the More Important Diseases of Women," appearing in 1837, is particularly interesting. Little progress was made until January 30, 1878, when Freund began performing his radical abdominal operation, after cauterizing the cervix or even amputating it when large. I cannot but yield to my sense of justice in passing and mention here that Freund employed as an essential feature of his procedure, in 1878, the very position so well described in 1891 by Trendelenburg and that has since borne his name. It remained for our American gynecologist, Emil Ries, of Chicago, to plan and recommend a very radical operation for cancer of the cervix which he succeeded in having performed in 1895, by the late Wertheim. Ries has been an indefatigable investigator of this affection and deserves great credit. Nor can we leave this subject without alluding to the inestimable original work in this affection that was done by John G. Clark and X. O. Werder at about the same time that Ries and Wertheim were beginning their work in Berlin.

The galvanocautery as employed by John Byrne, Skene and many others following their advocacy of it, has been most efficacious.

Of obstetrics one must speak with considerable reserve. The untrained obstetrician has been the weak spot in our preparedness. The famous teachers — Parvin, Barker, and others did not to a desirable extent impress our profession with the importance of this specialty. This, no doubt, was in part due to its being a heritage from the midwife, who has striven to claim it as a possession. In later years an earnest effort has been made by a few very efficient teachers to secure to obstetrics a proper recognition. The vigorous propaganda by Williams has probably aroused the medical schools to an appreciation of the necessity for much better facilities for real teaching of obstetrics. From a course practically didactic, with manikin demonstrations and no clinical work, it has been transformed into one clinical as well as didactic. In the last few years clinical obstetrics has been a strong feature in the medical school curriculum. The requirements of the examining boards of the various states reflect the appreciation of necessity of better equipment for the practice of obstetrics and has been a very strong factor in the marked improvement in obstetric training.

A complaint of inefficient teaching of gynecology in the past may be made in full justice. Dealing with the diseases of the female genitalia has had an inherent delicacy which has deterred the teacher from bringing students in as close relation to gynecological patients as to those suffering from diseases of other parts of the body. I submit clinical work as viewed from the amphitheatre has little superiority over didactics and students must be brought in close touch with disease in order to study it to greatest advantage.

Of the child, abdominal surgery, we may well say it remains at home with its parents. For, surely, it was brought into existence by gynecology and obstetrics. When we recall the fearless abdominal surgery of Lawson Tait, the cholecystotomy of J. Marion Sims, and the determined effort of the latter to establish prompt laparotomy with suture of the injured viscera as the accepted treatment of gunshot injuries of the abdomen, we at once see the relation of parent and child.

Even the first nephrectomies known to history (both fatal), that of Walcott, of Milwaukee, June 4, 1861, and Spiegelberg in 1867, were done with the pre-operative diagnosis of ovarian or hepatic cyst. The first successful nephrectomy, that of Simon, in 1869, was done for a severed ureter complicating an ovariotomy. The genius Sims did the first cholecystotomy. Thomas' operation of gastro-elytrotomy was a leader for more precise and better obstetrical abdominal surgery. Much has been written, and timely, regarding the unpleasant sequelæ of laparotomies. A remarkably large proportion of patients whose abdomens had been invaded suffered from intraperitoneal adhesions, intestinal obstruction, fæcal fistula, sloughing ligatures, and various other unfortunate conditions originating in the operations. This was such a sad commentary upon abdominal surgery that it acted as an obstruction to the rapidity of growth of the justifiability of this variety of surgery. So much for abdominal surgery as placed upon a sound basis by gynecology and obstetrics.

As yet the general surgeon had little to do with abdominal surgery. Nor was his attention directed practically to it until the specialists mentioned had ripened and prominently and enthusiastically praised this great field of surgery. Its early days without general anæsthesia or asepsis must be reviewed by us with shuddering amazement. Many of us have seen it without the latter, when it seemed disheartening. To Crawford W. Long, who, like Sims, had been an obscure village physician, and to the creators of clean surgery we owe no small obligation. It has been markedly developed during the last thirty-five years so that now no portion of the lower half of the torso has any unknown parts. Even the suprarenal body is being resected for quite definite indications.

It would be unpardonable not to give due credit to bacteriology for its powerful aid in arriving at the intelligent treatment of infections found in the pelvis and the abdomen. One is led to wonder at the lateness of this correlation of bacteriology with gynecic and

abdominal surgery. Even as late as December, 1879, in a debate in which many of the leading surgeons of London participated, Mr. Timothy Holmes was able to say: "No convincing proof of the germ theory as applied to living tissue and living phenomena has as far as I know yet been offered." It was not until 1881 that the observations of Ogston on the relations of micro-organisms to surgical diseases were published. And not until the publication of Rosenbach, in 1884, and of Passet, in 1885, were the varieties and natural history of the common organisms of suppuration fully described and their identity established. These had to be preceded by the epoch-making researches of Koch on staining methods and culture media. Since then this branch of medicine has attained by wonderful strides a position of vast importance in the three great fields of medicine under consideration.

During the forty years' existence of this society there have been times when it has seemed the problems of gynecology and obstetrics were practically all solved; that nothing new was to be learned and that solely practical application of known facts was to be their future. This was, indeed, a gloomy view, for the generation that marks no advance over the work of the preceding one is practically dead. In the field of investigation of the better cementing of the brotherhood of man and of the uplifting of the human family — in all these — advances must be constant. In fact the very existence of such specialties was thought to be jeopardized. The mechanical part of gynecology, surgery, was being largely taken up by the general surgeon, who, giving little heed to the real foundation of gynecology — that of the study of womankind—perhaps thought that operations constituted the whole field of this branch of medicine. The family physician, entering the practice of his profession very poorly trained in the science and practice of obstetrics, soon secured a rather large obstetric clientele absolutely by propinquity. He promptly learned that women served in time of such suffering were deeply appreciative and retained his services for other professional necessities. Such conditions naturally lent themselves to the creation in many minds, even in some great ones, of distinct fear of extinction of these two great sister specialties in our science. And yet the jeopardy was more threatening from other directions. Ominous clouds passed in review. In many medical colleges gynecology, no longer regarded as an important specialty, was obliged to assume an insignificant rôle in the work of the chair of surgery. In others it was combined with obstetrics in one chair. While recognizing both specialties, this plan robbed both of their dignity and prestige.

Another effort to terminate the existence of at least one of these branches of science was that of the section on surgery of the American Medical Association, at a meeting a few years ago to have its sphere extended to include gynecology and abdominal surgery. It failed, however, and at a subsequent meeting of the association abdominal surgery was added to the work of the section on obstetrics and diseases of women. I understand an amicable adjustment has been made putting abdominal surgery in both of the sections mentioned. The situation of gynecology and obstetrics may now be regarded as stable. I believe no fear need exist of loss of recognition of either. Both are very healthy adults and not to be regarded as "infant industries" needing fostering care. No distinct pause in their development has occurred since the organization of this society. The training of the medical student in gynecology is on a splendid plane. The graduating student is far more proficient in gynecology today than was the general physician of several years' experience a short time since. The carefully prepared case histories — prepared by students under efficient supervision — the thorough laboratory investigations and opportunity for carefully supervised physical examinations bring the students to a basis for logical diagnosis — the paramount necessity for correct treatment. The clinical teacher who frequently states "something is wrong in this abdomen and I will open it and then make the diagnosis," endangers his reputation.

In the teaching institutions the same plan

of instruction in obstetrics obtains to a considerable degree. Both obstetrics and gynecology are gaining in this respect and while we do not expect marvelously rapid transformation in such matters, owing to the marked changes in hospital construction and régime necessary thereto, nevertheless a sense of pleasure has come to the teachers in these branches of medicine from the progress of the last few years.

In abdominal surgery the dread of dire results from sepsis, ignorance, shock, hæmorrhage, and several other former causes of needless mortality has nearly vanished. While problems in this field of endeavor remain unsolved, diseases of the abdomen are much better understood than formerly. Various aids are now being employed to assist in the diagnosis or treatment of pelvic and abdominal diseases, and I dare say they will have notable extensions. The roentgen ray has greatly assisted in the discovery and location of adhesions, neoplasms, ulcers, and stases of the stomach and intestine, determining the presence or absence of biliary, renal, and ureteral calculi and indeed, with the ureteral catheter, is an extremely reliable agent for determining whether urinary calculi above the bladder exist. We are justified in believing it will prove of great value in diagnosing pregnancy and various abdominal and pelvic tumors. Laboratory findings in luetic and Neisserean, tubercular and other infections, though of great importance, must and will assume a still greater rôle in our agencies. I feel sure that even improvements will be made in more careful investigation of patients' histories to determine the time for operation as well as in the technique to be followed. Already the surgeon is cautious in radically invading infectious areas, often delaying with advantage, when the less skillful would fairly plunge into a surgical operation. F. F. Simpson has recommended marked delay, even months, for radical operations in infections in and about the uterine appendages. The value of this plan can scarcely be questioned and its universal acceptance may be expected in the treatment of patients who can afford the extra time this requires. It is another feature in the conservative practice that goes with greater knowledge. In ectopic pregnancy his advocacy of delayed operation has been quite universally heeded.

The subject of displacement of the uterus from time immemorial has been a fruitful one for lively and even bitter discussion. Careful study of the forces maintaining the position of that organ are gradually lessening the differences of the past in this respect and we may reasonably hope for full accord in it. Pelvic non-puerperal infections are steadily losing their terrors, and we may look for them to be practically removed from the class of highly dangerous diseases. This will be largely due to the recognition of the superiority of dependent drainage and conservation in their radical treatment.

The treatment of cancer of the uterine cervix continues to receive the very earnest attention of gynecologists, and special activity in the general subject of cancer during the past three years has been enthusiastically aided by this society. Thus far the cause of cancer has not been found and no doubt this must be discovered before we may reasonably expect to gain a mastery over this dreadful disease. Its behavior, as influenced by radium and long-continued, slightly elevated temperature, as advocated by Percy, is of interest. The use of certain rays from radium seems to retard its progress and, perhaps, completely destroy it while other rays from it are thought to induce the disease. If the latter be a fact we may well refuse to believe, for the present, that cancer is of microbic nature. Even the Percy method emphasizes this doubt for it should stimulate microbic activity; yet its retarding influence on the progress of cancer of the cervix is attested by many careful and reliable observers. But neither of these two agents can be regarded as a specific for this disease for they are both notably limited in their radius of action. Whether radium has deeper penetrating power as a cancer destroyer than the Percy heating method is a matter of doubt and the cases reported by Boldt throw grave doubt on the penetrating power of Percy's method used for this purpose. This latter method is based upon the application of a low elevation of heat to the involved tissues. And yet

for this purpose is employed an instrument so hot that it has constantly to be moved to prevent overheating and the heat is gauged principally by the sense of touch through the uterine wall, which varies greatly in individuals. If this method is proved a specific against the active agent of cancer, is it not to be the sole agency in the treatment and cure of cancer in the breast, bladder, vagina, vulva, and rectum? If it has a positive specificity for two inches then no part of the human body will be inaccessible to its beneficent influence.

It would appear, then, that our hope in cancer of the uterus continues to consist of surgery, as early as possible, universal education on this subject, the employment of radium and high or higher temperatures and unremitting search for the true etiology of it. Radium offers benefit to other forms of neoplasms, particularly to the bleeding uterine fibroid, according to several credible observers. Nevertheless it is yet but an empiric agent, not available to more than a very small percentage of patients suffering from the many conditions in which it is extolled and not without its evil effects, such as corrosion of tissue. While we may believe enthusiastic faith has had much, far too much, to do with the reported results of radium application, we cannot fail to recognize that this agency, when properly harnessed, has great possibilities in the treatment of pathological conditions. I believe it is deserving of being absolutely divorced from charlatanry and commercialism. Its exploitation has been unfortunate.

In obstetrics, a nearly parallel situation is found in the aid and sympathy several prominent workers and teachers have afforded the sensational use of the various alkaloids of hyoscyamus and opium under the alluring name of "twilight sleep." In the sweeping march over the continents of this dangerous method, the professional and moral fibers of even the flower of the obstetric world have been challenged. It has nearly equaled the tales of the French revolution. It is believed the danger of this awful flood has passed and the conscientious and competent obstetrician may now come down from his Mount Ararat and pursue the even tenor of his way. Probably humanity has been benefited by this visitation only to the extent that it has prompted us to take stock of our methods and even of our humaneness, and has appealed, perhaps not unnecessarily, to still greater concern for the suffering of our patients. The outcome of it is: superior substitutes for opium and hyoscyamus are now employed. Probably the open mind is now predicting that at no distant date "twilight sleep" will rarely be recalled to memory and nitrous oxide and oxygen inhalations during labor will be given an enduring place in the obstetric régime.

It is highly probable that cæsarean section will be given a wider field of application. The vulnerability of tissues of women, certainly of American women, will be fully recognized and they will not be subjected to unreasonable and unbearable obstetric strain and avoidable infant mortality. Much greater advance in teaching obstetrics may be expected than has been obtained. Largely to J. Whitridge Williams should we attribute such improvement.

In abdominal and pelvic surgery at its present stage of development, probaby no more important matter is before us than the prevention and correction of interperitoneal adhesions. A propaganda on this subject should result in untold lessening of human suffering. Very likely an active educational campaign would greatly lessen the evil of post-operative adhesions. The finding of large areas of adhesions in the abdomens of patients who have been previously subjected to laparotomy for simple or "clean" conditions is far too common to escape the attention of the careful abdominal surgeon. Nor is it always the tyro that unnecessarily violates the parietal and visceral peritoneum, by undue handling, suturing, etc. Various materials have been extolled as prophylactics against post-operative adhesions. I will not tax your time by enumerating them but will refer to a few of them. Vaseline, highly regarded by some of America's greatest abdominal surgeons I feel I must severely criticize. One to three years after I had smeared it over denuded peritoneal areas I have re-

moved from the abdomens of patients encysted masses of vaseline having diameters up to one inch, and have found adhesions were very extensive. In some places these capsules of vaseline formed a dense, rigid, connecting structure between several loops of intestines. Acting upon the theory that "before a fibrous exudate can form in the peritoneal cavity with its resultant plastic agglutination, there must be the liberation of that hypothetical ferment, thrombokinase, its activation of prothrombin in the presence of calcium and the production of thrombin," Saxon Pope [1] experimented on sixty rabbits and published his work in January, 1914. These experiments were made with many different materials and he concluded from this work that a solution of 2 per cent sodium citrate in a 2 per cent solution of sodium chloride was the best remedy. His faith in his conclusions is proved by his reporting in February, 1916,[2] the results of the employment of this hypertonic solution in 400 abdominal operations in the University of California Hospital. Walker and Ferguson,[3] doing 104 operations on 63 rabbits, found 3 per cent of the citrate in 1 per cent of sodium chloride solution was the most satisfactory, giving complete success in 70.5 per cent and 88.2 per cent partial success. Certainly such results merit our attention. In the presence of sepsis or deep or wide destruction of tissue it is not claimed these hypertonic solutions can be regarded as infallible, but even here they are of use. In my personal experiences with the 3 per cent solution of the citrate in quantities of 200 to 300 cubic centimeters considerable shock has been noted. Among the questions that arise in our minds are:

1. If it gives absolute success in 70.5 per cent in mild peritoneal traumatism, can its use be extended to success in such severer peritoneal injuries as separated adhesions?

2. How long must it be in contact with the area to be of highest efficiency?

3. What is the duration of its activity?

4. Can it be used efficiently in gauze covering large areas of peritoneal denudations and brought out through the abdominal wall?

If these questions are to be later answered satisfactorily to us, then we will have positively mastered this much dreaded and dangerous complication — peritoneal adhesions.

Coffey has recently invited attention to his rubber cofferdam, brought through the abdominal opening, used in separating pelvic adhesions in acute attacks of adnexal infections. Though he specifically claims no hernia follows this prolonged abdominal drainage, I fear that claim will not tempt many to use this method of dealing with such conditions. I believe the paraffin-stearic gauze recommended by Fisher [4] used as a drainage material for pelvic adhesions and conducted through the vagina will be found very satisfactory. While I have not attempted to be a seer, yet I have been so impressed by some of these efforts to lessen the dreadful peritoneal adhesions that I have been emboldened to risk tiring you with this rehearsal.

We are at great loss for lack of knowledge of the influence of luetic infection on the pathological conditions we as specialists must treat. In the past the degree of precision in diagnosis of this variety of infection has been so slight that we have not been able to associate with it observed lesions to the degree of certainty that the Wassermann reaction now permits. The routine blood examination reveals a startling frequence amounting almost to regularity of the positive Wassermann which quite reliably indicates the presence of lues. It is to be hoped the attention given to this subject at this meeting of our society will have the much needed stimulating influence on the profession in general necessary to a due appreciation of the momentous importance of recognition of lues in obstetrics and gynecology.

Surely there are very many grave problems to be solved in the fields of endeavor you represent but I am unboundedly confident this society will in the future maintain in that work the prestige that has come from the high character of work it has performed.

[1] Ann. Surg., Phila., 1914, lix, 101.
[2] Ann. Surg., Phila., 1916, lxiii, 205.
[3] Ann. Surg., Phila., 1916, lxiii, 198.
[4] J. Am. M. Ass., 1916, lxvi, 939.

EPIPLOITIS FOLLOWING HERNIOTOMY[1]

By WILLIAM HESSERT, M.D., F.A.C.S., Chicago

DISEASES of the omentum are relatively uncommon, and literature on the subject is scant, especially in the English language. Omental diseases are either tumors or inflammations. The former include carcinoma, sarcoma, lymphangioma, cysts, and teratomata. The inflammations are divided into two groups, which include, first, the cases that occur postoperatively, and, second, those not preceded by operation. Herniotomy is the operation most frequently concerned in the first group, and since ligation of the omentum is done in only a small minority of hernia operations, it follows that epiploitis as a complication is likely to be uncommon. Some operators with large experience in hernia work have never encountered it.

The most recent publication on the subject of inflammatory tumor of the omentum is by L. Peterhanwahr.[2] This author has collected 44 cases, 36 of which had been preceded by operation, mostly herniotomies. Lucas-Championière observed two cases of epiploitis among 275 operations for hernia, Dubois one in 300 cases, and Tuffier one in 600 cases.

The French literature contains the first reference to this subject in 1892 by Lucas-Championière, followed by Reynier in 1893, Forgue in 1896, and later by Boeckel, Meniere, Morestin, Le Dentu, and others. Schnitzler's article in 1900 was the first to appear in German. Cumston and Hamann are among the few who have written on the subject in this country.

American writers on hernia scarely mention the possibility of epiploitis following ligation of the omentum. While it is true that epiploitis is a rare complication in this country, due to the general use of absorbable ligature material, yet the matter is of more than academic interest and should be familiar to every surgeon. The fact that two cases occurred within a short period in the writer's practice, suggests the belief that more cases would be diagnosed were there a better understanding of the subject.

The case histories which follow illustrate the acute and chronic types of the disease.

Case 1. A young man had been operated upon for a moderately large left inguinal hernia. A large piece of omentum was removed *en masse*, and one heavy piece of iodine catgut was used. The patient progressed normally for about eight days, at which time the wound had healed by first intention. Then the patient developed a fever, and complained of abdominal pain on the left side. Nausea and vomiting ensued, the abdomen became distended, and the bowels failed to respond. The abdominal pain became general, and all the symptoms were intensified. When seen by the writer on the twelfth day of the disease, the condition of the patient was desperate. He presented the typical picture of general peritonitis, and it was impossible to determine whether any relation existed between the peritonitis and the preceding herniotomy.

The abdomen was immediately opened by means of a left rectus incision on a level with the umbilicus. The peritoneal cavity was full of pus under high tension; the fluid was turbid and flaky, and the bowels were covered with exudate. The ligated pedicle of the omentum was found in the upper left quadrant of the abdomen. It was a mass the size of a lemon, covered by exudate, and saturated with pus. The adhesions to the abdominal wall were easily separated, and it was seen that the tumor was closely attached to the transverse colon. The catgut ligature was still intact. A hurried examination revealed no lesion of bowels, bladder, or other organs. Nothing was done further than drain, but the patient died twenty-four hours after.

This infection of the peritoneal cavity could have been introduced in no other way than by the retracting omental stump. The omentum became contaminated during the progress of the operation, and the pedicle proved a favorable medium for bacterial growth. The catgut was not at fault, for the same material was employed in the repair of the hernia, which healed *per primam*.

Case 2. A man 40 years of age had a large right inguinal hernia which was operated on, and a large piece of omentum was removed by the aid of several catgut ligatures. The wound healed without infection, and the patient left the hospital at the end

[2] Arch. f. klin. Chir., 1915, cvi, 355.

[1] Read before the Chicago Surgical Society, March, 1916. (For discussion see p. 366.)

of two weeks. After a free interval of about two weeks he began to suffer vague abdominal pains. Two weeks later he consulted the writer and complained of general malaise, anorexia, constipation, pains on the right side of the abdomen, and a swelling about the level of the navel.

Examination of the site of operation was negative —the hernia had healed perfectly. The abdomen was slightly distended, and the muscles on the right side were somewhat rigid. To the right of the umbilicus a mass could be felt which was about four inches in diameter, and fairly well circumscribed. It was sensitive to pressure, and did not move with respiration. There was dullness, almost flatness on percussion, but a zone of tympany separated this area from the liver.

There was nothing about the findings to suggest involvement of the liver or kidney, and the mass was rather higher up in the abdomen than the ordinary appendiceal abscess. There was an evening rise of temperature to 100°, and a leucocyte count of 10,000. The urine was negative, and further physical examination was negative. These findings, with the history, should have suggested the diagnosis.

The abdomen was opened through a right rectus incision directly over the tumor, which was found adherent to the abdominal wall. The adhesions could be readily separated, and the mass freed from the wall and underlying bowels. Upon delivery, the mass was found to consist of inflamed omental tissue. Almost all that was left of the omentum was involved, there remaining only a small bridge of healthy tissue where it was attached to the transverse colon. This was fortunate, for it permitted easy ligation and removal of the whole tumor. The inguinal region was found on examination from the inside to be perfectly normal. The patient recovered from the operation and remained well.

The tissue removed was hard and dense, being composed of fibrous and fatty tissue, with preponderance of the former. In the center of the mass several small abscesses were discovered from which staphylococcus aureus was grown. No trace of the ligatures could be discovered. This case illustrates the most commonly observed type of epiploitis; namely, the subacute variety. It differs only from the ordinary in that catgut was used instead of the more notorious offender—silk. While a number of the reported cases have recovered spontaneously, the findings in this case preclude the possibility of recovery without operation.

A number of types or varieties of epiploitis are described by various authors, but the classification of Peterhanwahr seems to be the best.

1. Post-operative variety. (*a*) Simple inflammatory hyperplastic type. (*b*) Suppurative epiploitis.

2. Extension from neighboring organs, not following operation.

Sauget describes three varieties as follows: (*a*) Epiploitis plastica simplex. (*b*) Epiploitis plastica with adhesions. (*c*) Epiploitis purulenta.

The variety most commonly observed is the simple inflammatory hyperplastic. The free interval after operation before the onset of symptoms is variously reported at five days to three years. In the majority of cases, however, it will average three to four weeks.

The type of inflammation which develops in the given case depends upon the virulence of the infection or the degree of mechanical irritation. In the very acute cases, of which an example is reported in this paper, the acutely inflamed omentum is but part of a general peritonitis. As the process becomes more chronic, the inflammatory products become more organized and fibrous. The mass may look like a fibrolipoma, and on section one or more abscesses are usually found with the ligature as a nucleus. Adhesions to the abdominal wall are most constant, and at times large abscesses have developed which were opened by the surgeon or gained a spontaneous exit. Sinuses have form and persisted due to the presence of masses of silk.

There remains finally to be mentioned the slowly growing chronic form which so much resembles a malignant tumor that diagnostic errors are almost inevitable. The structure of the mass is so dense and fibrous that this, together with the absence of pus, simulates the gross appearance of malignancy closely. It is the opinion of many that the mechanical irritation alone of the silk, without any accompanying infection, is capable of developing the large fibrous growths which have been encountered.

The factors primarily involved in the development of epiploitis are the following:

1. The ligature material.
2. The manner of ligation.
3. The condition of the omentum at the point of ligation.
4. Infection.

1. *The ligature material.* In about 90 per cent of the reported cases the material used was heavy silk (Reynier, Monod,

Guinard, Braun). In a small percentage of the cases other material, such as catgut or kangaroo tendon, was employed. Silk alone, without added infection, has been known to stimulate the development of enormous fibrous masses. This is explained by Hollander on the theory that while the ligature may have been drawn tightly enough on the pedicle to secure hæmostasis, it did not produce necrosis, and this bit of living tissue in the stump was stirred into tumor-like growth by the irritation of the silk. I am inclined to the belief that there is an element of infection in all of these cases. Virulent infection will result in any of the acute types of sepsis, while a mild infection may eventually become sterile, or result in sinus formation. Such sinuses will not close until the offending silk is eliminated. Absorbable ligatures, when infected, provoke the same disastrous results as silk. The absorbability of the material, when sterile, precludes the possibility of any late irritative effect.

2. *The manner of ligation* has much to do with the occurrence of epiploitis. The case records show, with few exceptions, that the omentum was ligated either *en masse*, or with a figure-of-eight ligature. This bunching of the omentum into one ligature has been a fruitful source of trouble.

3. *The condition of the omentum at the point of ligation* has had much to do in contributing to a bad result. Thus, if section is made through diseased tissue, the result of chronic inflammation as is so frequently observed on old or incarcerated hernias, the retracted pedicle becomes a source of trouble. Reynier, Roche, Boeckel, and others report cases of this kind in which silk was used.

4. *Infection.* It seems probable that infection is the most important factor, acting either alone or in conjunction with any of the other predisposing causes. That the irritation which results in the formation of large tumor-like masses is entirely mechanical is open to question. How often do we see silk when sterile heal in the tissues without causing any reaction whatever? When large fibrous masses develop, we have bacterial irritation added to the stimulus of the foreign body, the silk ligature. It is conceivable that a low grade of infection after producing its effects might become sterile, and cultures taken from the silk would show no growth, thus lending support to the mechanical theory.

SYMPTOMS

In the very acute cases the symptoms arise a few days after operation, and consist of the usual signs of an acute infection within the abdomen, ending with general suppurative peritonitis. In rare instances the process may become localized with abscess formation.

By far the majority of the cases run a subacute or chronic course lasting for months or even years. The free interval after operation is generally of four to eight weeks' duration, but cases are on record in which two to three years elapsed before the onset of symptoms.

Pain is one of the first and most constant symptoms. It may at first be in any portion of the abdomen, depending on the location of the inflammation. Frequently it is in the upper abdomen, and is aggravated by deep breathing, coughing, or tight clothing. Associated with the pain there is usually a rise of temperature, with all its attending symptoms. There may be an absence of signs pointing to any special organ, and in some cases the symptoms all subside, and the patient gradually makes a spontaneous recovery. More often the disease continues progressive, with finally all the signs of a localized abscess in the abdomen manifest. The pus in such cases may rupture into the bowel, or succeed in burrowing through the abdominal wall.

In the type of cases that develop slowly and insidiously, with vague and ill-defined symptoms, there is great resemblance to the clinical course of a cancer. The presence of a palpable mass is further suggestive of malignancy. In doubtful cases, the abdomen has been opened, and even then the operator is in doubt whether the tumor is a carcinoma, sarcoma, or of inflammatory origin.

DIAGNOSIS

In every case of a herniotomy where abdominal symptoms supervene, the possibility of epiploitis must be considered. It is very likely that there have been many cases which

have not been recognized or have been incorrectly interpreted because epiploitis in this connection has received but little attention. Diagnosis is suggested by the occurrence of pain associated with the development of a mass in the abdomen. The tumor is usually on the same side as the herniotomy, on a level with or above the umbilicus. The tumor has been but rarely seen in the pelvis or inguinal region. The tumor varies in size, but has been known to grow very large. It is tender on palpation, and is usually fixed to the abdominal wall so that it does not move with respiration. There is usually dullness or flatness on percussion, as the intestines are beneath the mass.

In differential diagnosis one must consider cholecystitis, subacute appendicitis, chronic perforation of the stomach, foreign body (such as a gauze sponge), diverticulitis of the sigmoid and pancreatitis.

TREATMENT

According to Braun the development of an inflammatory tumor of the omentum after herniotomy does not necessarily demand operation, for a fair proportion of such cases recovers under expectant treatment. It is fair to assume, however, that the diagnosis in some of the recovered cases might be open to some question.

The most radical view relative to treatment was expressed by Reynier, one of the early writers, who advised extirpation of the tumor as though it were malignant.

The practical lesson to be learned is that we should be familiar with epiploitis, as it may complicate recovery after a herniotomy, and adopt the measures necessary for prevention. These are in fact elementary, and include first a faultless operative technique, both aseptic and mechanical. There should, above all, be an avoidance of rough handling of tissues. Portions of the omentum should not be removed at all during the performance of a hernia operation unless there is a valid indication. If resection must be made, then absorbable suture material of as small a size as possible should be employed. The vessels in the omentum should be tied with many fine ligatures, and the use of *en masse* or figure-of-eight ligatures should not be considered. Section should always be made through healthy omental tissue, never allowing any diseased tissue to slip back into the abdominal cavity.

After the diagnosis of epiploitis has been made, the decision for operative interference rests with the judgment of the surgeon. The acuteness of the symptoms, and the progress of the disease would be determining factors. Under ordinary conditions no harm can follow an exploratory incision. It is best to remove the inflammatory mass completely if possible. If owing to adhesions and abscess formation, removal is impossible, then there should be thorough drainage.

In the event of intestinal obstruction caused by an old fibrous inflammatory mass, it may be necessary to resect or shortcircuit the bowel.

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THE TRANSPLANTATION OF THE ARTICULAR END OF BONE INCLUDING THE EPIPHYSEAL CARTILAGE LINE

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In a previous paper, entitled "The Experimental Transplantation of the Epiphysis," the effect of transplantation on the longitudinal growth of bone has been considered by the author (1). The results of those experiments show that the longitudinal growth ceases after transplantation of the epiphyseal cartilage line, whether by itself or with a neighboring piece of epiphyseal or diaphyseal bone. In the present article a description of the macroscopic and microscopic changes occurring in the various components of such a transplant will be given.

Thus, it becomes necessary to consider the changes occurring in the articular cartilage, the marrow and the trabeculæ of the epiphysis, the epiphyseal cartilage line, the marrow and the trabeculæ of the diaphysis and the cortical bone. Normally there are certain constructive and destructive changes taking place in a growing bone, but with the additional influences of transplantation the complexity of the study is considerably increased.

In order to understand clearly the changes that take place, it will be advisable to describe minutely the structure of the epiphyseal end of a growing and developing bone, because certain terms not given in the usual histological descriptions are employed in the text and also because it is necessary to express in definite defining terms what is understood as epiphysis, epiphyseal cartilage line, and metaphysis, which are so often very loosely employed.

Normal epiphysis. In the very early periods of bone development the epiphysis is entirely cartilaginous. With the appearance of the center of ossification there is a gradual disappearance of the cartilage until only a shell remains surrounding the cancellous epiphyseal bone and marrow (Fig. 7). The cartilage at one end persists to form the articular cartilage, while that at the inner boundary forms a part of the epiphyseal cartilage line. This part of the epiphyseal line toward the epiphysis will be designated as the epiphyseal ossifying cartilaginous layer (Fig. 1). It consists of hyaline cartilage with irregularly scattered nuclei and, from its epiphyseal side, ossifying buds of cartilage extend into the epiphysis. In the older animals the part of the shell of cartilage connecting the articular cartilage with the epiphyseal cartilage line undergoes complete ossification so that the articular cartilage is no longer found to be inserted into the epiphyseal line. The remainder of the epiphyseal cartilage line is composed of columns of cartilage-cells, the nuclei of which are flat and heavily stained near the epiphyseal ossifying cartilage layer but gradually become round and larger on nearing the metaphysis, until they finally are of a vesicular structure with a surrounding light staining protoplasm. These large vesicular cells form the boundary between the epiphysis and the metaphysis and finally become a part of the latter. It is by the proliferation of the cartilage-cells of the epiphyseal cartilage line that the longitudinal growth of bone is maintained. The exact process of this procedure will not be considered at present.

Normal metaphysis. The metaphysis is made up of osteoid tissue in which there are numerous vascular loops. Extending into the diaphysis are long irregular columns of cartilaginous matrix which are in various stages of ossification, from partial at their beginning in the metaphysis to complete at their ending in the diaphysis. This will be designated as the metaphyseal ossifying cartilaginous layer (Fig. 1). There is a rich vascular marrow between these columns of ossifying cartilage.

The material for this report was obtained from seventy-five experiments on dogs, mostly in the early growing period. All of the opera-

tions were performed under general ether anæsthesia during which the usual aseptic measures were employed. At the conclusion of the experiment the foot was protected by a light plaster-of-Paris dressing which was allowed to remain from fourteen to twenty-one days, the animal in the meantime having full freedom. At the conclusion of the experiment all of the metacarpal and metatarsal bones were measured in order to determine the amount of growth. From a large series of measurements in normal animals it was found that the two central bones of the metacarpal or metatarsal region of the same and of the opposite side, are all practically of equal length (Fig. 2). This affords a standard of comparison and allows an easy method of determining the amount of actual growth. As the metacarpals and metatarsals possess but one epiphysis, situated at the distal end of the bone, any change in growth that takes place can only be caused by proliferation from that particular epiphyseal cartilage line.

Roentgenograms were taken of the feet in many instances. Part of the specimen was preserved in Kaiserling's solution and part used for microscopical study. The tissue for microscopical examination was fixed in Orth's fluid, embedded in celloidin, and the cut sections stained with hæmotoxylin and eosin or Van Gieson's stain. Fifty-eight of the more important experiments[1] are described in detail.

REIMPLANTATION OF EPIPHYSEAL CARTILAGE LINE

Method. The distal end of the bone is exposed until the epiphyseal cartilage line is visible. By means of a sharp scalpel a cross section of the bone in the region of the epiphyseal cartilage line, including an adjoining piece of the diaphysis and the epiphysis, is excised and immediately reimplanted. The width of such a section is about 0.4 cm. The piece is anchored in place by an X-shaped suture over the dorsal surface and the wound closed in layers. At the termination of the experiment the animal is killed by means of gas.

Experiment 1. Duration 4 days. Dog 24-14, age 1¾ months.

Macroscopical description. The healing is normal. There is no growth of either normal or operated bones. The reimplanted segment is in contact with the host at its distal but not at its proximal end.

Microscopical description. The articular cartilage appears normal. The marrow of the epiphysis shows definite evidence of degeneration in both the reimplanted piece and in the host. The trabeculæ of the epiphysis show a uniform failure of staining of the bone-corpuscles and appear to be undergoing early degeneration. The epiphyseal cartilage line presents a rather normal appearance aside from an increase in width. The metaphysis shows a normal arrangement of the ossifying cartilage columns but there is some lack of nuclear staining. The intervening marrow is necrotic. The marrow of the diaphyseal part of the transplanted segment is undergoing necrosis. The nuclei of the trabeculæ of the diaphysis stain faintly and appear to be degenerating. The small amount of cortex of the transplant is lacking in nuclear staining. The elements of the host appear normal throughout.

Experiment 2. Duration 17 days. Dog 31-36, age 1¾ months.

Macroscopical description. The healing is normal. There is no growth of the normal or the operated bone but there is a considerable thickening in the region of the implanted cartilage.

Microscopical description. The articular cartilage became displaced following the operation so that the outer surface is turned inward allowing an abnormal penetration of fibrous tissue into the articular cartilage. The marrow of the epiphysis with the exception of a small area on the dorsal side, near the epiphyseal cartilage line is replaced by young connective tissue in which are some fat-cells. The trabeculæ of the epiphysis are for the greater part made up of a homogeneous non-cellular tissue. Some of the trabeculæ, especially near the epiphyseal cartilage line on the dorsal surface, begin to show a proliferation of new osseous tissue about their periphery. The epiphyseal cartilage line is markedly changed, only a band of cartilaginous tissue remains, which corresponds to the epiphyseal ossifying cartilage layer. The cartilage columns are entirely replaced by fibrous and vascular tissue. The metaphyseal ossifying cartilaginous zone is replaced by new formed osteoid tissue. In the diaphyseal marrow there is a slight increase of polymorphonuclear cells. The trabeculæ and cortex have a normal appearance.

Experiment 3. Duration 23 days. Dog. 23-13L, age 1½ months.

Macroscopical description. Good healing is present. The growth of the operated bone is 0.2 cm., while the normal is 0.4 cm. The articular cartilage appears smooth and the marrow of the epiphysis is fairly normal. The epiphyseal cartilage line is thickened. There is a whitish streak in the distal part of the line and a broad band of white tissue in the region of the metaphysis. The lines

[1] In these experiments the word "host" refers to the part of the bone that was not transplanted.

of union are still distinct. The remainder of the bone appears normal.

Microscopical description. The articular cartilage is normal in appearance, aside from a slight fibrous deposit on the outer layer of the perichondrium. The marrow of the epiphysis distal to the transplant is of normal appearance, while that of the transplant is necrotic and fibrous except for a small area on the dorsal side near the epiphyseal cartilage line. The trabeculæ of the epiphysis show a considerable amount of osteoid proliferation about the homogeneous central part (Fig. 3). The epiphyseal cartilage line is almost double the normal width. A distinct line of cleavage is seen in the rows of columnar cartilage which divides them transversely into a proximal two-thirds and a distal one-third. This line corresponds to the white streak mentioned in the gross description. The cells of the epiphyseal cartilage have a normal structure with the exception of those near the line of cleavage. The cartilage columns are elongated and appear to be increasing in length. The metaphyseal ossifying cartilage columns are elongated. The marrow of the diaphyseal part of the transplant is necrotic and fibrous, while that of the host is normal. The trabeculæ of the diaphysis show new osseous tissue on their borders. The cortex of the host presents an active periosteal new bone formation near the line of union. At one place on the outer border of the cortex there is a node of osseous and cartilaginous material in which one can plainly see the proliferation of the periosteum to form new bone. This outgrowth is most likely associated with an injury to the periosteum during the operation.

Experiment 4. Duration 44 days. Dog 33–44L, age 1½ months.

Macroscopical description. There is good healing. The operated bone is lengthened 0.1 cm. while the normal bone is increased 0.7 cm. (Fig. 4). The line of union cannot be distinguished. The bone is swollen in the region of the implanted cartilage line. The epiphyseal cartilage line is irregular, being quite narrow at the center and proximal to it in the metaphyseal region is a white streak which appears to be degenerated tissue.

Microscopical description. Upon the surface of the articular cartilage there is a layer of fibrous tissue. Its inner layers appear quite irregular and there is a penetration of fibrous tissue into its substance. These changes in the articular cartilage are most likely due to trauma at the time of operation. The marrow of the epiphysis appears normal. The majority of the trabeculæ are entirely regenerated except the central parts of some, as shown by their poor staining at that point. The epiphyseal cartilage line is very irregular, being quite narrow at the center and of normal width at the sides. The peripheral parts appear fairly normal although the cartilage columns are curved and show beginning degenerative changes. In the middle there is an entire absence of the columns which are replaced by fibrous and osseous tissue. The metaphyseal region is entirely replaced by osseous trabeculæ. The remainder of the transplant and host appears normal.

Experiment 5. Duration 55 days. Dog 38–26R, age 4 months.

Macroscopical description. The healing is normal. The operated bone is 0.2 cm. smaller than at the time of operation, while the non-operated bone is 0.1 cm. longer than before. The joint and the articular cartilage appear fairly normal with the exception that the cartilage has a bluish tinge. The entire epiphysis appears larger than normal. The bone on longitudinal sections appears eburnated and there is still a small remnant of the epiphyseal cartilage line. The roentgenogram shows this line but the absence of any line in the normal bones makes it more likely that it is persistent cartilage at the line of union.

Microscopical description. The joint cartilage, the trabeculæ and marrow of the epiphysis are of normal appearance. The epiphyseal cartilage line is entirely lacking, there being only several small remnants of irregularly arranged cartilage and fibrous tissue in the line of union. The remainder of the transplant and host appear normal.

Conclusion on Reimplantation of the Epiphyseal Cartilage Line

In general the changes are confined to the reimplanted tissues. The earliest changes are seen in the marrow-tissue where there appears to be a necrosis of the greater part, even as early as the fourth day. The marrow spaces at 17 and 22 days are filled with a fibrous connective tissue, but at a later period a further differentiation takes place and new marrow is formed. In these experiments on account of the close proximity of the normal tissues of the host, it is impossible to determine the origin of the regenerated tissue.

The first evidence of degeneration of the epiphyseal cartilage line is seen at 23 days and appears as a cleavage line extending through the cartilage columns, so as to divide it into a proximal two-thirds and a distal one-third. Later a progressive degeneration of the epiphyseal cartilage line occurs as is shown by the 44-day and 85-day experiments, there being almost a complete disappearance of the cartilage in the latter experiment.

The trabeculæ undergo degenerative changes as early as 4 days, and at 23 days there is regeneration from the periphery which is practically complete at 44 days.

The transplant heals in place so that at 44 days there is no evidence of the line of union.

AUTOTRANSPLANTATION OF THE EPIPHYSEAL CARTILAGE LINE

Method. In this set of experiments a cross section of bone from the region of the epiphyseal cartilage line, including a piece of adjoining epiphyseal and diaphyseal bone, is transferred to take the place of a similar section from a corresponding bone of the opposite foot.

Experiment 6. Duration 23 days. Dog 23–13R, age 1¾ months.

Macroscopical description. There is good healing. The increase in length of the operated bone is 0.2 cm., while the normal bone is increased 0.6 cm. The bone is broader than the normal especially at the epiphyseal end. The articular cartilage is smooth. The lines of union are just visible. The epiphyseal cartilage line is rather irregular and has lost its normal gelatinous appearance. Just proximal to the epiphyseal cartilage line is a band of tissue of white color and the bone in that region is denser than normal.

Microscopical description. The articular cartilage is of normal structure except for a small defect at one place on the surface. The marrow of the non-transplanted part of the epiphysis is normal while that of the transplanted piece contains scattered areas of necrotic marrow. The trabeculæ of the non-transplanted part of the epiphysis are normal while those of the transplanted portion are poorly stained, especially toward their centers. The epiphyseal cartilage line is divided into a proximal two-thirds and a distal one-third on account of the degeneration of the tissue in that region (Fig. 5). The parts on either side of the cleavage line present a fairly normal appearance. The cartilage beneath the perichondrium is in a state of active development. In the metaphysis the provisional ossifying cartilage columns have a rather irregular appearance and there is a fibrous and necrotic change of the marrow. The line of union of the diaphysis is quite distinct, especially near the periosteum where there is a considerable amount of callus. There is an increase of leucocytes in the diaphyseal marrow near the line of union.

Experiment 7. Duration 23 days. Dog 23–13L, age 1¾ months.

Macroscopical description. The appearance in general corresponds to that found in the previously described experiment. The normal bone has increased 0.4 cm. while the operated bone has only increased 0.2 cm. The epiphysis, however, is denser. The epiphyseal cartilage line has not the same tendency to separate, and the diaphyseal part of the transplant is less dense than normal.

Microscopical description. The articular cartilage shows some slight changes in the inner layers and there is a fibrous deposit on the surface. The marrow of the epiphysis is composed of loose fibrous tissue, throughout which are scattered marrow elements both in the transplant and in the host. In the trabeculæ there is a marked proliferation about the periphery of the dead central portion. This applies to the trabeculæ, both in the transplant and to the part of the host near the line of union. The line of union in the epiphysis is fibrous in the center and cartilaginous at the sides. The epiphyseal cartilage line is broadened and shows a line of cleavage as in the previous case. There is a considerable cartilaginous proliferation at the outer ends. In the metaphysis the provisional ossifying cartilage columns are undergoing osseous change. The intervening marrow is chiefly fibrous, only a few marrow elements being present. The elements of the host appear normal.

Experiments 6 and 7 which were performed on the same animal show some variation in the findings, in spite of the fact that the duration of the experiment was the same in each case. It is possible that the discrepancy in the results was due to the fact that on the left side there was more injury to the vascular supply, as an adjoining bone was operated upon at the same time; and because the size of the two transplants is different, being 0.4 cm. wide on the right and 0.7 cm. on the left.

Experiment 8. Duration 55 days. Dog. 9–4, adolescent.

Macroscopical description. The healing is good. There is no growth in the normal or operated bone. The joint cartilage is of a blue color and the epiphyseal cartilage line is absent. The marrow has a normal color.

Microscopical description. The articular cartilage appears normal. The marrow is mature, being composed of fat and diffusely scattered cellular elements. The trabeculæ are quite large and are made up of compact, well-stained bone. The epiphyseal cartilage line has entirely disappeared so that the marrow of the diaphysis and the epiphysis merge into each other. The diaphysis is of normal appearance.

Experiment 9. Duration 89 days. Dog 10–5, age 3 to 4 months.

Macroscopical description. The length of the operated bone is 0.3 cm. less than normal, while the non-operated bone is 0.1 cm. longer. The marrow appears normal. The epiphyseal cartilage line cannot be distinguished.

Microscopical description. In the articular cartilage there is a diffuse arrangement of cartilage-cells of the inner layer but little evidence of degeneration. The marrow of the epiphysis is composed of fatty mature marrow. The trabeculæ are normal. The epiphyseal cartilage line is entirely absent,

except for two small remnants of cartilage near the border. The diaphyseal marrow and trabeculæ are similar to those of the epiphysis.

Experiment 10. Duration 136 days. Dog 32–39L, age 1¾ months.

Macroscopical description. Good healing is present. The operated bone is 0.35 cm. longer, while the normal is 1.4 cm. longer than at time of operation (Fig. 6). There is a considerable thickening of the capsule, but the articular cartilage appears normal. The marrow of the epiphysis appears normal. The epiphyseal cartilage line is quite irregular and has lost its normal gelatinous appearance. On one side there appears to be an ingrowth of articular cartilage into the area previously occupied by the epiphyseal cartilage line. The remainder of the bone appears normal.

Microscopical description. There is a marked fibrous thickening on the surface of the articular cartilage. In some places the articular cartilage has lost its regular structure and there has been a considerable infiltration of fibrous tissue. The marrow of the epiphysis is rather scanty and throughout there are masses of poorly stained tissue. The trabeculæ of the epiphysis in general are normal. The epiphyseal cartilage line is almost entirely absent, there remaining only a small amount of fibrocartilage. The articular cartilage on one side is penetrating inward along the cartilage line, resembling somewhat the attachment of the articular cartilage to the epiphyseal cartilage line as is found in the young developmental condition. The metaphysis is occupied by a considerable amount of fibrous tissue. The remainder of the bone of the diaphysis resembles that of the epiphysis.

Summary on Autotransplantation of the Epiphyseal Cartilage Line

This series of autotransplantations of the epiphyseal cartilage line is not sufficiently complete to definitely determine each step of the degenerative and regenerative processes. However, there are enough sections to allow for the following deductions.

An early restoration of the marrow takes place in the transplant as is shown in the section at the twenty-third day.

The trabeculæ of the transplant at first degenerate and then regenerate by the formation of osseous tissue beginning at the periphery.

The epiphyseal cartilage line shows an early degeneration and at 23 days there is a definite line of cleavage separating it into a distal one-third and a proximal two-thirds. The degeneration progressively increases with the length of the experiment and at 135 days only a slight remnant of the line is found.

Changes take place in the marrow of the host similar to those at the line of union in the transplant.

COMPARISON OF REIMPLANTATION AND AUTOTRANSPLANTATION OF THE EPIPHYSEAL CARTILAGE LINE

In both autotransplantation and reimplantation changes in the transplant take place immediately after excision. The marrow becomes necrotic as is seen in the section at 4 days, then there is a fibrous change and finally a regeneration of the marrow. The process is about the same in both the autotransplantation and reimplantation. The trabeculæ likewise show early degeneration and later regeneration. The process of regeneration of the trabeculæ seems to bear a relation to the relative amount of connective tissue present and is perhaps slightly more rapid in the case of reimplantation.

The changes in the epiphyseal cartilage line are variable, unless the experiments are performed in exactly the same way. More or less injury at the time of operation or the size of the transplanted segment seems to influence the results. Thus in a reimplantation experiment at 17 days there is a more active degeneration than at 23 days but it is found that the articular cartilage is displaced in the 17-day experiment, thereby affecting the result. The processes of degeneration are very similar in the reimplantation and autotransplantation but are perhaps a little more rapid in the latter.

REIMPLANTATION OF VARYING LENGTHS OF THE EPIPHYSEAL END OF THE METACARPAL AND THE METATARSAL BONES

Method. After exposing the metacarpal or metatarsal, the bone is sectioned at the desired place. The capsule of the joint is opened and the entire transplant including the articular surface is removed, care being exercised not to injure the epiphyseal cartilage line. The bone is immediately reimplanted. It is held in place by a suture passed through the cortex of the host and transplant and by sutures passing from the surrounding tissues over the articular end of the bone. Different lengths of bone are used

in the various experiments in order to determine if the size of the transplant exerts any influence on the results.

Experiment 11. Duration 12 days. Two-thirds length. Dog 30–38, growing animal.

Macroscopical description. Good healing is present but union is not firm. There is no increase in length of either operated or normal bone. The articular cartilage appears normal. The marrow of the transplant is paler than normal. The epiphyseal cartilage line is broadened and there is a pale white line extending through distal one-third.

Microscopical description. The articular cartilage appears normal. In this section the normal relation of the articular cartilage to the epiphyseal cartilage line, as is found in the early developmental stages, is easily made out. It is continuous with the epiphyseal ossifying cartilaginous layer of the epiphyseal line (Fig. 7). The marrow of the epiphysis is almost entirely necrotic (Fig. 8). The nuclei of the trabeculæ appear pale and are evidently degenerating. The epiphyseal cartilage line is swollen (Fig. 7). In the distal one-third the cartilage columns are distorted and there is more intercellular hyaline tissue than usual. The remainder of the epiphyseal line appears normal. In the metaphysis the provisional ossification zone is of normal arrangement but the nuclei of the cells are indistinct. The marrow of the diaphyseal part of the transplant is necrotic. The nuclei of the trabeculæ take a pale stain and show evidence of early degeneration. The cortical bone is made up of pale staining nuclei except beneath the periosteum where there is some new osseous tissue. The bone of the host appears normal.

Experiment 12. Duration 13 days. One-third length. Dog 30–38, young animal.

Macroscopical description. The appearance is similar to that described in the previous experiment.

Microscopical description. The articular cartilage appears normal. The marrow of the epiphysis is necrotic. The nuclei of the trabeculæ of the epiphysis are pale but do not appear to be so extensively degenerated as in the previous experiment. The epiphyseal cartilage line is broader than normal but its cellular elements appear almost normal. In the metaphyseal part, the columns of ossifying cartilage are in part degenerated, those near the periphery show evidence of proliferation. The bone of the host appears normal.

In comparing the last two experiments it is evident that the degenerative processes are more rapid and extensive in the transplanted segment which is the longest.

Experiment 13. Duration 17 days. One-half length. Dog 31–36L, age, 1¾ months.

Macroscopical description. Good healing is present but owing to the displacement of the transplant it is ununited (Fig. 10). There is practically no growth of the operated and the non-operated bone.

Microscopical description. The articular cartilage appears normal except for a fibrous thickening on the outer surface and small areas in which the nuclei stain poorly. The marrow of the epiphysis is substituted by vascular, fibrous, and fatty tissue with here and there some necrotic marrow. The trabeculæ of the epiphysis stain rather homogeneously, the nuclei appearing as shadows. There is evidence of early regeneration on the periphery of the trabeculæ. These cells look like young osteoblasts and appear to be closely related to the surrounding fibrous tissue. The epiphyseal cartilage line is degenerating as is shown by the fragmentation of the cartilage-cells and distortion in the regular columnar arrangement. There is a definite line of cleavage in the proximal one-third of the epiphyseal cartilage line (Fig. 11). In the metaphysis there is very little evidence of ossification of the cartilage, except at one border where there is a rich network of osteoid tissue. The intervening marrow is fibrous as is the marrow of the diaphysis. The trabeculæ of the diaphysis are scanty, showing a homogeneous central part about which there are osteoblasts forming new bone. The cortex of the transplant is made up of two parts, an inner homogeneous degenerated part and an outer cellular part composed of young new-formed osteoid tissue. In this experiment the cortex of the host and the transplant are in poor contact and it is interesting to note that the greatest amount of new osseous tissue is produced from the periosteum and endosteum on the side most distant from the host (Figs. 10 and 12). It is evident that this regenerated tissue is formed by the periosteum and endosteum of the transplant independently of the host. The cortex of the host is normal (Fig. 13).

Experiment 14. Duration 22 days. Two-thirds length. Dog 22–12L, age 1¼ months.

Macroscopical description. There is good healing and union of the transplant and the host. There has been no growth of operated bone, while the normal has increased 0.5 cm. The articular cartilage appears to be in good condition but there is a thickening of the synovial membrane. On longitudinal section of the transplant the marrow appears pale and yellow in contrast to the normal red color of the host. The epiphyseal cartilage line is broader than normal but shows no definite defects.

Microscopical description. The articular cartilage appears normal, except for a slight fragmentation of some of the cells of the middle layer and the pale staining of the inner layer. The marrow spaces of the epiphysis are occupied by a loose meshwork of connective tissue in which are numerous cellular elements suggesting the beginning re-formation of the marrow. The bone trabeculæ appear degenerated but some are beginning to show regeneration as is evidenced by a proliferation of osteoblasts on the periphery to form young bone.

There is also a considerable formation of subperiosteal bone on the lateral borders of the epiphysis. The epiphyseal cartilage line is wider than normal. At one border there is a large defect in the cartilage but aside from some fragmentation and irregularity in the distal one-third of the cartilage columns, the epiphyseal cartilage line is of normal appearance. On the epiphyseal side near the epiphyseal ossifying cartilage layer, which stains poorly, there is considerable amount of newly formed osteoid tissue. In the metaphysis there is a lack of the active ossification of the cartilage columns which appear elongated and are separated by fibrous tissue instead of marrow. The marrow spaces of the diaphysis are filled with loose fibrous tissue in which there are a considerable number of marrow-cells. The trabeculæ of the diaphysis are very numerous and the older ones show definite evidence of regeneration about their borders. The cortex of the diaphysis of the transplant is made up of old degenerated bone about which there is newly formed osseous tissue which seems to arise from the periosteum, endosteum and in the haversian canals. The most marked regeneration is on the plantar side, which is in part due to the ingrowth from the host. There is definite evidence that the bone of the transplant has some property of forming new bone independent of ingrowth from adjoining bone of the host. The elements of the host appear normal.

Experiment 15. Duration 38 days. Three-fourth length. Holes bored in the transplant. Dog 37–40R, age 2 months.

Macroscopical description. There is good healing and union is firm. There is no growth of the operated bone, while the normal bone has increased 0.3 cm. The roentgenogram shows the shortening and absorption of the transplant (Fig. 14). The articular cartilage appears normal, although it is much thicker than normal. The epiphyseal end of the transplant is darker than the diaphyseal part, the latter being quite pale when compared with the normal. The epiphyseal cartilage line is quite distinct but is thinner and more irregular than normal. Proximal to the epiphyseal cartilage line in the metaphyseal region is a white band extending across the bone.

Microscopical description. The articular cartilage is much wider than normal and there is a tendency for the cells to form in groups. There is an occasional cell-shadow but little evidence of degeneration, except as is shown by the poor staining of some of the cells of the inner layer. The marrow of the epiphysis is practically all fibrous with a few scattered marrow-elements in some parts. The trabeculæ of the epiphysis are almost entirely regenerated; some, however, still show the dead centers with new osseous tissue about the periphery (Fig. 9). In the epiphyseal cartilage line there are numerous large holes both in the columns and at the junction with the metaphysis. The epiphyseal ossifying cartilage layer is well maintained. The metaphysis is replaced by fibrous tissue and osseous trabeculæ. The marrow of the diaphysis is fibrous but becomes quite cellular at the end near the host, as though the latter were playing a considerable rôle in its regeneration. Numerous osteoblasts are present. The trabeculæ show advanced regeneration; those farthest away from the host are in the most advanced stage, again indicating the independency of the regeneration of the different elements of the transplant. The cortex of the transplant is thin and in places it is separated by bands of fibrous tissue. This appearance is due to the ingrowth of fibrous tissue into the holes that are bored into the transplant. The degenerated parts are being substituted by new periosteal and endosteal bone, which does not appear to be definitely related to the host. At the line of union there is still considerable fibrous tissue and very little tendency of the cortical bone of the host to invade the transplant. The host is of normal appearance, except at the line of union, where there is some fibrous tissue invasion of its marrow cavity.

Experiment 16. Duration 44 days. One-half length. Dog 33–44R, age 1½ months.

Macroscopical description. There is good healing and firm union. There is no growth of the operated bone, while the normal bone is 0.7 cm. longer than it was at time of operation (Fig. 15). The articular cartilage appears white in comparison to the pink color of the other bones. The capsule of the joint appears normal. On longitudinal section the transplanted piece is pale, the articular cartilage is broader than usual, the epiphyseal line is indistinct, and there is a white band across the metaphysis.

Microscopical description. The articular cartilage is broad and is divided into two different regions, an outer in which the nuclei are stained deep and an inner in which they are stained light. The cells themselves do not appear to be degenerated. The marrow-spaces of the epiphysis are occupied by loose fibrous tissue in which are scattered numerous new formed marrow-elements especially on the dorsal surface. The trabeculæ of the epiphysis are partially regenerated. There are also some new formed trabeculæ. The epiphyseal cartilage line is in an advanced stage of degeneration (Fig. 16). The epiphyseal ossifying cartilage layer is best maintained but even that is being invaded by osseous and fibrous tissue. The columns of cartilage of the epiphyseal line have been entirely replaced by fibrous and osseous tissue. At the periphery of the epiphyseal cartilage line there is a considerable proliferation of cartilage beneath the perichondrium, both in the region of the columns and in the ossifying cartilage of the epiphysis (Fig. 16). The ossifying cartilage columns of the metaphysis are entirely osseous and between them is fibrous tissue. The marrow of the diaphysis is partly regenerated, being intermingled with vascular connective tissue. The trabeculæ of the diaphysis are fully restored; in fact there is a marked increase of osseous tissue

throughout this part of the transplant. The cortical bone is quite irregular and appears to be undergoing absorption about its borders. The line of union is bony and it is possible that the transplant is being regenerated by the host. The host appears normal.

Experiment 17. Duration 115 days. One-third length. Dog 34–43L, age 1¾ months.

Macroscopical description. There is good healing and firm union. The growth of the operated bone is 0.45 cm., while that of the non-operated bone is 1.2 cm. (Fig. 17). The joint capsule is thickened. The articular cartilage is blue and has lost its normal form. On the longitudinal section the marrow appears yellowish, the epiphyseal cartilage line is absent, and the cortex is thinner than normal.

Microscopical description. The articular cartilage is of normal arrangement and the cells appear quite intact. The marrow of the epiphysis is normal, being composed of marrow-elements and fat. Some of the trabeculæ are normal, while others are made up of a cartilaginous center surrounded by normal bone. In some of the earlier stages the trabeculæ are practically all osseous and it is rather difficult to explain the persistence of the cartilage at this time. The epiphyseal cartilage line is represented by a thin osseous cartilaginous band extending across the bone (Fig. 18). The metaphyseal region is occupied by fatty marrow. The marrow cavity of the diaphysis is filled with normal fatty marrow in which are a few scattered trabeculæ. The cortical bone of the transplant is of normal appearance except that it is not arranged in the normal, even and regular manner. There is a considerable amount of erosion on the outer surface and osteoclasts are quite numerous. The line of union persists as a thin band of bone. The bone of the host appears normal.

The operated bone shows 0.45 cm. increase in length since the time of operation. This is the only instance in the series in which there is any appreciable growth. It is possible that under some especial favoring circumstance the epiphyseal cartilage line retains the property of increasing the length of the bone. In spite of this fact, the normal bone has increased three times as much as the operated bone and its epiphyseal line persists, while the epiphyseal line of the transplanted bone has disappeared (Fig. 17). Therefore, even if the transplanted epiphyseal cartilage line in this instance retains its power to proliferate, it does so only temporarily and to a very limited degree.

Experiment 18. Duration 115 days, two-thirds length. Dog 34–43R, age 1¾ months.

Macroscopical description. There is good healing and firm union. The growth of the operated bone is 0.15 cm. while that of the normal bone is 1.45 cm. (Fig 19). The entire specimen was preserved in Kaiserling.

Summary on Reimplantation of Varying Lengths of the Epiphyseal End of the Metacarpal and Metatarsal Bones

The articular cartilage shows only slight changes in the inner layers which is indicated by an irregularity in the arrangement of the cells and the loss of some of the nuclear stain.

The marrow undergoes an early necrosis. It is possible that some of the cells may persist and later share in the regeneration but this point cannot be definitely determined. The later stages show the marrow-spaces filled with fibrous connective tissue after which there is a gradual restoration of the marrow.

The trabeculæ even at 12 days show disappearance of their nuclei, and in the later stages there is a gradual regeneration which takes place through a peripheral substitution of the old bone. This regeneration occurs independently of the host and seems to bear some relation to the surrounding fibrous tissue.

The epiphyseal cartilage line at first shows a crumbling of the cells at the junction of the proximal two-thirds and distal one-third. Then a fissure appears in this region following which there is a continuous and progressive degeneration of the entire cartilage. The more persistent part is the epiphyseal ossifying cartilage band. There is only a very limited attempt at regeneration in the parts just beneath the perichondrium.

The marrow of the diaphysis undergoes the same changes as it does in the epiphysis and there is no earlier regeneration in spite of its close proximity to the host, although it might receive additional elements from the host.

The changes in the trabeculæ of the diaphysis do not differ from those in the epiphysis.

The cortical bone at first degenerates and is then regenerated by new bone which is formed from the endosteum and periosteum. In some of the sections there is a considerable amount of erosion beneath the periosteum. It is difficult to determine whether the bone is later substituted from the host, but at first it is definitely formed from the original periosteum and endosteum of the transplant.

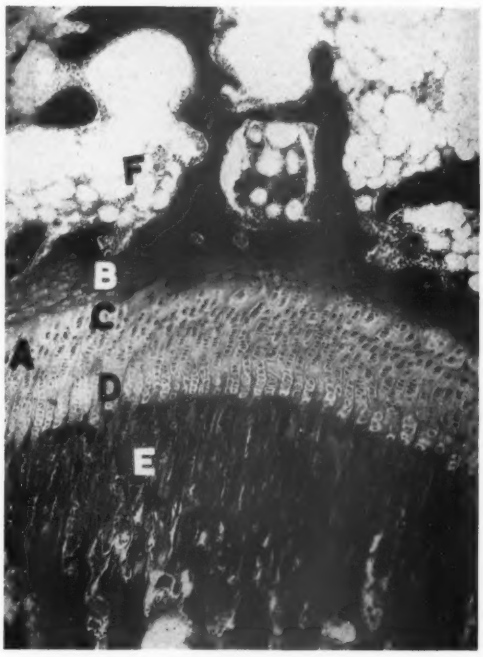

Fig. 1. Normal epiphysis and metaphysis of a dog at 2½ months. *A* Epiphyseal cartilage line; *B* epiphyseal ossifying cartilaginous layer; *C* columns of cartilage with flat and heavily stained nuclei; *D* columns of cartilage with vesicular nuclei forming the boundary between the epiphysis and the metaphysis; *E* metaphyseal ossifying cartilaginous layer, showing ossifying cartilage columns between which are marrow-elements; *F* trabeculæ and marrow of the epiphysis. Microphotograph: obj. ⅔; oc. 2 inches; B. & L.

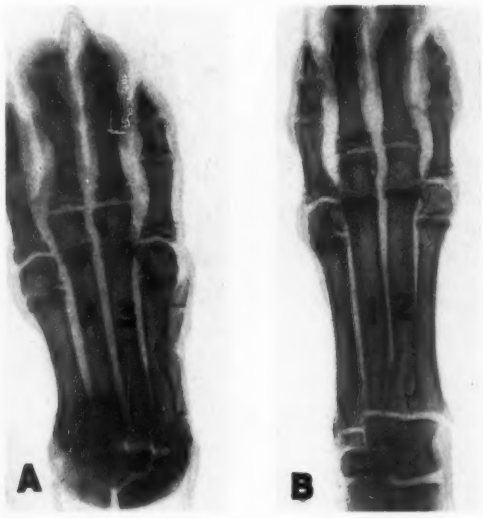

Fig. 2. Roentgenogram of the normal fore and hind feet of a dog, showing the relative lengths of the metacarpal and metatarsal bones. *A*, Forefoot. Notice that the metacarpal bones, *3* and *4*, are of equal length. This affords a standard of comparison and a method whereby the amount of growth can be estimated. *B* Hind foot. Notice that the metatarsal bones, *1* and *2*, are practically of equal length.

AUTOTRANSPLANTATION OF VARYING LENGTHS OF THE EPIPHYSEAL END OF THE METACARPAL AND METATARSAL BONES

Method. These experiments consisted of removing different lengths of the distal end of the metacarpal or metatarsal bones, including the epiphyseal cartilage line and exchanging it with a similar piece from one of the bones of the opposite foot. The technique is the same as that employed in the reimplantation.

Experiment 19. Duration 34 days. One-half length incisions. Dog 19–5R, age 5 months.

Macroscopical description. The healing is good and firm union exists between the transplant and the host. There is no growth of the transplanted bone, while the normal growth is 0.6 cm. The joint is in good condition although there is a thickening of the capsule. The marrow of the transplant is scanty. The epiphyseal cartilage line can still be made out as a thin line on longitudinal section.

Microscopical description. The articular cartilage is quite irregular. The persisting cartilage is of normal arrangement but the nuclei are shrunken. The marrow near the articular cartilage is quite normal while the remainder is fibrous. The trabeculæ of the epiphysis are more numerous than usual but they stain poorly with the exception of the part near the periphery of some, where there is newly formed bone. The epiphyseal cartilage line is in part entirely replaced by fibrous tissue while the remainder is undergoing rapid degeneration. The epiphyseal ossifying cartilaginous layer is the best maintained. The metaphysis is entirely replaced by fibrous and new osseous tissue. The marrow of the diaphysis is entirely fibrous. The trabeculæ of the diaphysis are composed of new bone although in the center of some are old nuclear free remnants of bone. The original cortex is homogeneous and the nuclei appear as shadows. There is a new formed endosteal and periosteal bone about the old cortex. At the line of union there is a large amount of callus of both endosteal and periosteal type which comes from both the transplant and the host. The ends of the cortical

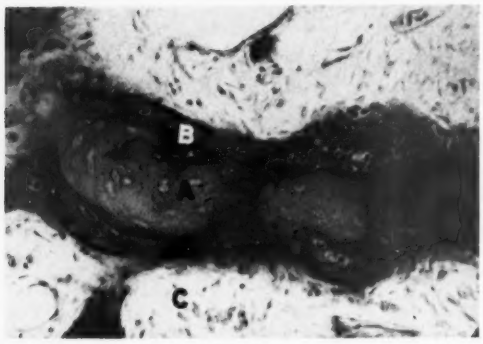

Fig. 3. Experiment 3, 23 days, Dog 23–13. Regeneration of the trabeculæ after transplantation takes place by the formation of new osseous tissue about the periphery of the dead bone which is gradually substituted. It occurs independently of the host and is the same in autotransplantation and in reimplantation. *A* Dead bone; *B* new osseous tissue on the periphery; *C* organization of the marrow. Microphotograph: obj. 1/6; oc. 2 inches; B. & L.

Fig. 4. Experiment 4, 43 days, Dog 33–44L. Reimplantation of the epiphyseal cartilage line. Second bone from the right, *4*, shows reimplanted epiphyseal line with 0.6 cm. shortening. The metacarpals, *3* and *4*, are normally of equal length.

fragments take a very minor part in the formation of this callus. The elements of the host appear normal.

Experiment 20. Duration 34 days. Split one-half length. Dog 19–5L, age 5 months.

Macroscopical description. The healing is good but the union is not firm. There is no growth in operated bone while the normal is increased about 0.6 cm. The articular cartilage is rough and irregular. The epiphyseal cartilage line is markedly changed. In this experiment the transplant has been split longitudinally before insertion.

Microscopical description. The articular cartilage is rough and irregular and in places is entirely absent. The splitting of the bone is responsible for some of these changes. The marrow is replaced by fibrous tissue although on one side there are some marrow-cells which are possibly regenerated cells. The trabeculæ are made up of an outer new osseous layer within which is old dead bone. The epiphyseal cartilage line is fissured at the junction of proximal two-thirds with the distal one-third, but is not so extensively altered as it is in the previous experiment. The metaphysis is of fairly normal appearance although there is not the active proliferation as under normal conditions. The marrow-cavity of the diaphysis is for the greater part fibrous with some scattered areas containing new marrow-elements. There are some newly formed trabeculæ in the diaphysis, the older ones are necrotic or are surrounded by newly formed bone. The cortex of the diaphysis is homogeneous and without nuclear staining. There is a small amount of regenerated bone from endosteum, periosteum, and haversian canals. There is more evidence of regeneration at a distance from the host, than in the immediate vicinity. There is a considerable amount of callus from the host which is mostly derived from the periosteum and penetrates into the marrow-space between the host and transplant.

After splitting the bone some of the elements seem to retain their vitality longer.

Experiment 21. Duration 42 days. One-half length. Dog 21–11L, age 1½ months.

Macroscopical description. There is good healing and firm union of transplant and host. The transplanted bone shows no increase in length, while the normal bone is 0.6 cm. longer. The transplant is broader than normal. The articular cartilage appears thickened as is the capsule of the joint. The transplant is yellow instead of the normal red color. The epiphysis is wider than normal and has lost its gelatinous appearance. In the metaphysis there is a white band of new tissue.

Microscopical description. There is a marked fibrous thickening on the articular surface. The cartilage is rather irregular being thicker on one side than on the other. The cells, however, appear to be normal except in one area, where there is some degeneration. On the plantar side the marrow of the epiphysis is almost of normal appearance while on the dorsal surface it is fibrous. The trabeculæ of the epiphysis are almost entirely regenerated. The epiphyseal cartilage line shows extensive degenerative changes throughout, there being large holes, crumbling of the columns, and some invasion of fibrous tissue. There is a slight regeneration near the perichondrium on one side. The metaphysis is undergoing degeneration, which accounts for the white band seen in the gross specimen. The marrow of the diaphysis is partly

Fig. 5. Experiment 6, 23 days, Dog 23–13. Shows the degeneration of in the epiphyseal cartilage line 23 days after autotransplantation of the epiphyseal cartilage line. *A* Degeneration in the epiphyseal ossifying layer; *B* empty spaces and necrotic cartilage at the junction of the epiphyseal ossifying cartilaginous layer and the columns of cartilage. Microphotograph: obj. ⅔; oc. 2 inches; B. & L.

composed of normal elements and a part is substituted by fibrous tissue. The trabeculæ are entirely regenerated. The outer surface of the cortex is irregular and there is some evidence of periosteal new bone. The line of union is cartilaginous with a considerable increase of osseous trabeculæ on either side.

Experiment 22. Duration 43 days. Two-thirds length. Dog 36–42R, age 1½ months.

Macroscopical description. The healing is good and the union is firm. The increase in length of the operated bone is 0.1 cm., while the normal is 0.55 cm. (Fig. 20). The joint is well formed and contains a small amount of synovial fluid. The cartilage appears more white than normal. The epiphysis is of normal color. The epiphyseal cartilage line can hardly be distinguished, while in the metaphysis there is a white band of tissue that appears degenerated. The diaphyseal marrow is very pale and it looks as though there is a marked increase of the bone trabeculæ.

Microscopical description. The articular cartilage is practically normal in appearance. The marrow of the epiphysis contains a large number of

Fig. 6. Experiment 10, 136 days, Dog 32-39. Autotransplantation of the epiphyseal cartilage line. Second bone from the right, *2*, on each foot shows the autotransplanted cartilage line. No evidence of epiphyseal line. Increase in length 0.35 cm., normal increase 1.4 cm. Bones *2* and *3* are normally of equal length.

normal cellular elements but there is a considerable increase in vascularized connective tissue and fat. The trabeculæ of the epiphysis are practically entirely regenerated (Fig. 21). The epiphyseal cartilage line is distorted and degenerated (Fig. 22). Toward the periphery there is some regeneration of cartilage which appears to arise from the perichondrium and the outer cartilage columns, especially on the plantar side. The epiphyseal ossifying cartilaginous layer is ossified, while the remainder of the epiphysis is substituted by fibrous tissue (Fig. 22). The cartilage-cells at the junction of the metaphysis are fairly well preserved, while the ossifying cartilaginous columns are entirely changed into osseous tissue. The marrow of the diaphysis is made up of loose fibrous tissue in which are scattered many marrow-cells. There are a considerable number of new trabeculæ in the diaphysis and the old ones have been entirely regenerated, except for an occasional small piece. The cortex shows evidence of erosion in places and there is new periosteal and endosteal bone surrounding the old dead bone. As one approaches the line of union with the host there is more evidence of regeneration indicating that the host plays a part. The bone of the host appears normal except on one side near the line of incision, where there is some dead bone.

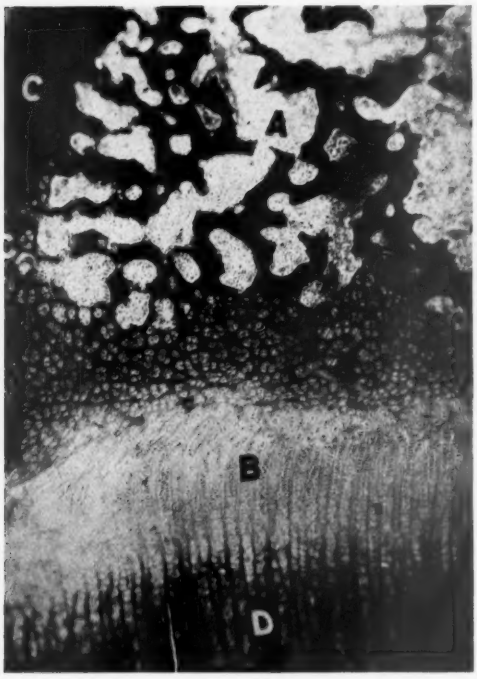

Fig. 7. Experiment 11, 12 days, Dog 30–38. Reimplantation of two-thirds of the epiphyseal end of the metacarpal bone. *A* Epiphyseal end containing necrotic marrow; *B* epiphyseal cartilage line wider and more irregular than normal; *C* articular cartilage inserted into the epiphyseal cartilage line as specimen is from a very young animal; *D* metaphysis. Microphotograph: obj. ⅔; oc. 2 inches; B. & L.

Experiment 23. Duration 43 days, two-thirds length. Dog. 36–42L, age 1½ months.

Macroscopical description. The appearance corresponds to its mate of the previous experiment except that the epiphyseal cartilage in this case is more intact than on the opposite side and the epiphysis is of a darker red color.

Microscopical description. The findings in general are similar to those of the previous experiment except that the marrow-cells are more abundant and the epiphyseal cartilage line is in a better state of preservation. There is also a line of columnar cartilage cells in the diaphysis which are possibly cartilage-cells remaining behind during the normal growth of the bone.

Experiment 24. Duration 43 days. One-third length. Holes bored into the transplant. Dog 40–37L, age 5½ months.

Macroscopical description. There is good healing. Neither the operated nor the normal bones show any evidence of growth in length since the operation. The joint-capsule is thickened and the joint cavity is filled with a fibrous tissue. The cut surface of the transplanted segment is of a white cartilaginous appearance. The roentgenogram shows the condition of the transplant (Fig. 23).

The entire specimen was preserved in Kaiserling's solution.

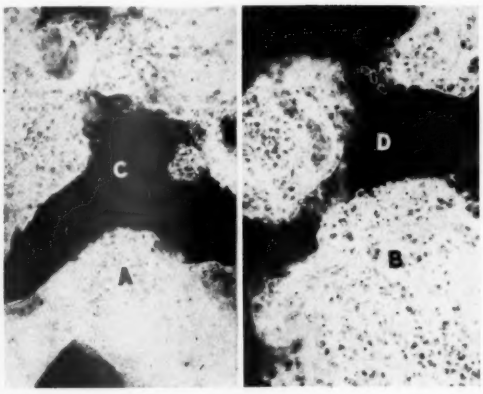

Fig. 8. Experiment 11, 12 days, Dog 30–38. Showing the early necrosis of the marrow 12 days after reimplantation of a segment of bone. *A* Necrotic marrow (this is a higher magnification of the marrow shown in Fig. 7.); *B* normal marrow of the host in the same experiment; *C* trabeculæ of transplant (overdeveloped in order to bring out the marrow); *D* normal trabeculæ. Microphotograph: obj. ⅙; oc. 2 inches; B. & L.

Experiment 25. Duration 43 days. One-third length. Dog 40–37R, age 5½ months. Homotransplantation. Holes bored into the transplant.

Macroscopical description. Good healing is present. This is the only example of homotransplantation in the series, the inserted transplant being taken from another animal. It is described at this time in order to allow for a comparison with the previous experiment. The operated bone measures 0.2 cm. less than it did at the time of operation, while the normal bone measures 0.15 cm. more. There is some roughening of the articular cartilage and thickening of the capsule. On longitudinal section the transplanted segment is of a yellow color and shows more evidence of degeneration than the autotransplant in the same animal. This is clearly shown in the roentgenogram (Fig. 23). The entire specimen was preserved in Kaiserling's solution.

Experiment 26. Duration 111 days. One-half length. Dog 35–41L, age 1¾ months.

Macroscopical description. There is good healing and firm union. The growth of the operated bone is 0.05 cm. while that of the non-operated bone is 1.4 cm. The joint-capsule is thickened and there is some roughening of the articular cartilage. On longitudinal section the bone is of normal color. The epiphyseal cartilage line is absent and in its place there is a small amount of soft tissue.

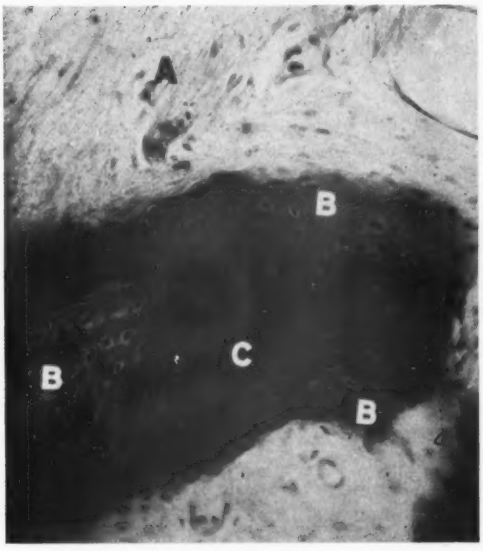

Fig. 9. Experiment 15, 38 days. Showing the method of regeneration of the trabeculæ by new bone beginning on the periphery. *A* Fibrous tissue in marrow-space; *B* new bone (notice deep staining of nuclei); *C* old dead bone (notice the shadows of the degenerated nuclei). Microphotograph: obj. 1/6; oc. 2 inches; B. & L.

Microscopical description. On the outer surface of the articular cartilage there is a thin layer of homogeneously stained tissue. Within this layer the cells appear normal in arrangement and structure. The marrow of the dorsal half of the epiphysis is normal, while that of the plantar side is degenerated and consists of necrotic tissue. The trabeculæ of the epiphysis appear normal. The epiphyseal cartilage line is represented by a small amount of cartilage, the greater part of which is absent, thereby allowing a communication between the marrow-space of the diaphysis and epiphysis. The metaphysis is entirely replaced by marrow and osseous tissue. The marrow and trabeculæ of the diaphysis appear normal. The cortex is composed of normal bone but there is a considerable amount of erosion on the surface and penetration of the surrounding connective tissue. The elements of the host appear normal.

Experiment 27. Duration 143 days. One-third length. Dog 29–37R, age 2 months.

Macroscopical description. There is good healing and firm union. The growth of the transplanted bone is 0.15 cm. while the normal growth is 1.5 cm. (Fig. 24). The joint-capsule is thickened but the articular cartilage appears normal. On section the epiphysis is pale and the epiphyseal cartilage line is absent. The epiphyseal cartilage line of the normal bone is not present.

Fig. 10. Experiment 13, 17 days, Dog 31–36L. Reimplantation of one-half of the epiphyseal end of a metacarpal bone. Mal-union. The independent regeneration of the various components of the transplant is shown in this section. *A* Transplanted segment; *B* host; *C* epiphyseal cartilage line (Fig. 11); *D* new formed osseous tissue from periosteum and endosteum which is entirely separated from the host (Fig. 12); *E* normal cortex (Fig. 12). Microphotograph: obj. 3 inches; oc. 2 inches, B. & L.

Microscopical description. The articular cartilage is of normal structure although the nuclei take a pale stain. The epiphyseal marrow is of the normal fatty type. The trabeculæ of the epiphysis for the most part have a normal structure although the nuclei of some take a light stain. The epiphyseal cartilage line is absent. The marrow of the diaphysis is normal and is confluent with that of the epiphysis. The trabeculæ of the diaphysis appear normal. The cortex is irregular in the region of the epiphysis where there is considerable erosion of its surface; otherwise it is normal.

Experiment 28. Duration 143 days. One-fourth length. Dog 29–37L, age 2 months.

Macroscopical description. There is good healing. The operated bone has increased 0.1 cm. in length, while the normal bone has increased 1.3 cm. The epiphysis of the normal bones are fully ossified (Fig. 24). The specimen was preserved intact.

Summary on Autotransplantation of Varying Lengths of the Epiphysis

In the autotransplantations there are more evidences of destruction of the articular cartilage than in any of the other experiments. In some sections there is considerable erosion and substitution with fibrous tissue; in others partial regeneration of cartilage.

The marrow of the epiphysis at first becomes necrotic. At a later period the marrow-spaces are occupied by fibrous tissue. At a still later period the marrow assumes

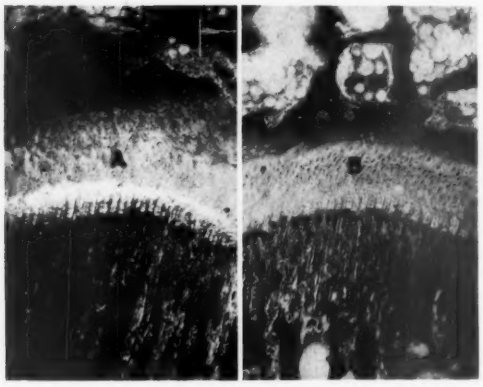

Fig. 11. Experiment 13, 17 days, Dog 31–36L. This is a higher magnification of the epiphyseal cartilage line shown in Fig. 10. *A* Epiphyseal cartilage line 17 days after transplantation; *B* normal epiphyseal cartilage line for comparison. Notice the irregularity, crumbling, and fissuring of the transplanted epiphyseal cartilage line. Microphotograph: obj. ⅔; oc. 2 inches; B. & L.

almost a normal structure. The regeneration seems to take place independently of the host. The exact method and source of the regenerated marrow could not be determined.

The trabeculæ of the epiphysis at first undergo degeneration, and then by a process of new formation beginning at the periphery are completely regenerated.

The epiphyseal cartilage line undergoes a progressive and complete degeneration. There is some regeneration beneath the perichondrium in the early stages. This new cartilage does not possess the normal property of increasing the length of the bone.

The marrow and trabeculæ of the diaphysis are subjected to the same changes as are the marrow and trabeculæ of the epiphysis.

The cortex at first shows extensive degeneration but later there is regeneration from the periosteum and endosteum independently of the host. However, in the later stages there is considerable bone erosion on the surface and fibrous tissue penetration.

COMPARISON OF REIMPLANTATION AND AUTOTRANSPLANTATION OF VARYING LENGTHS OF THE EPIPHYSEAL END OF THE METACARPAL AND THE METATARSAL BONES

The changes in the articular cartilage are more marked in autotransplantation than in reimplantation, although even in autotransplantation they are not very extensive.

In both autotransplantation and reimplantation the marrow of the epiphysis very early becomes necrotic. The necrotic marrow is replaced by fibrous tissue, which in turn is substituted by new marrow-elements. The regeneration appears to take place more rapidly in autotransplantation.

The trabeculæ of the epiphysis undergo practically the same changes in both autotransplantation and reimplantation, there being at first degeneration and later gradual new formation which begins on the periphery of the trabeculæ. The rate and degree of degeneration and regeneration are relatively the same in each case.

The epiphyseal cartilage line undergoes a gradual and persistent degeneration in both autotransplantation and reimplantation. In some cases the regeneration seems to be more rapid in the reimplantation than in autotransplantation, while in others the opposite seems to occur. In general the processes are similar in both instances.

The marrow of the diaphysis undergoes the same changes as in the epiphysis in both autotransplantation and reimplantation. The changes take place in about the same order and degree in both cases although there is perhaps an earlier regeneration in autotransplantation.

The changes in the trabeculæ of the diaphysis are similar to those which take place in the epiphysis.

The cortical bone in both autotransplantation and reimplantation at first degenerates and is then restored by means of proliferation from the periosteum, endosteum, and about the haversian canals of the transplant. There is erosion about the surface of the cortex in both groups but it is more intense in the autotransplantation. Although there is independent regeneration of the cortex from the periosteum and endosteum of the transplant, it can not be denied that the host plays a part in the new formation especially as concerns the permanent bone.

Firm union of the transplant and host occurred in both types of experiment.

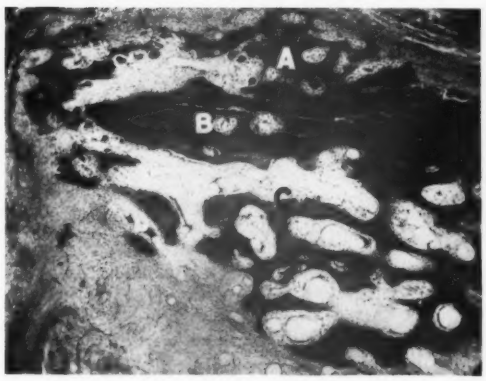

Fig. 12. Experiment 13, 17 days, Dog 31–36L. Higher magnification of area *D* shown in Fig. 10. *A* New formed osseous tissue from the periosteum of the transplant (no connection with the host); *B* new formed osseous tissue from the endosteum of the transplant (no connection with the host); *C* degenerated cortex of transplant in which the nuclei appear as shadows. Compare with normal cortex in Fig. 13. Microphotograph: obj. ⅔; oc. 2 inches; B. & L.

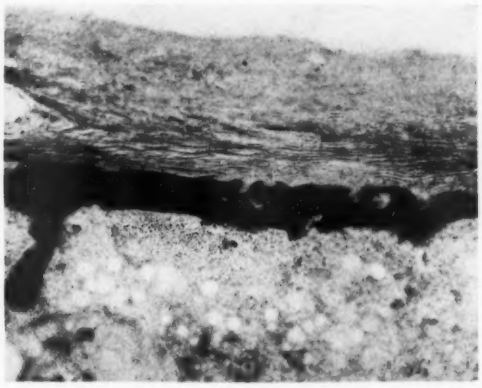

Fig. 13. Experiment 13, 17 days, Dog 31–36L. Higher magnification of area *E*, Fig. 10, showing normal cortex and marrow of the host. Notice the deep staining nuclei. Compare with *B*, Fig. 12. Microphotograph: obj. ⅔; oc. 2 inches.

TWO-STAGE AUTOTRANSPLANTATION OF DIFFERENT LENGTHS OF THE EPIPHYSEAL END OF THE METACARPAL AND THE METATARSAL BONES

Method. The two central metacarpal or metatarsal bones are exposed. By means of a sharp knife the two bones are transected at the same level. The proximal part of one bone and the distal part of the other is removed. The two remaining segments are united together by means of a suture passed through the cortex of each bone (Fig. 25). The wound is then closed. After sufficient time for union has elapsed another operation is performed, in which the distal segment containing the epiphyseal cartilage is separated from the surrounding tissue up to the line of union. Care is taken not to disturb the union or injure the epiphyseal cartilage line. The wound is closed and the foot encased in a light plaster-of-Paris dressing. In some of the experiments only the first stage of the operation is completed.

Experiment 29. Duration 22 days. First stage only. Two-thirds length. Dog 22–12R, age 1½ months.

Macroscopical description. There is good healing but the line of union is not firm. The operated bone is 0.1 cm. longer, while the non-operated bone is 0.4 cm. longer than normal. The articular cartilage appears normal. The transplant is of fairly normal appearance throughout.

Microscopical description. Only the proximal part of the bone, including the line of union is present in the section. There is a large amount of external callus on the plantar side arising from both host and transplant with a layer of fibrous tissue between the two ends. Numerous polymorphonuclear cells are to be seen at the junction. On the dorsal surface callus is present only on the side of the host. The marrow of the transplant appears normal except at the line of union, where there is an increase of polymorphonuclears. The trabeculæ appear normal. The cortex of the transplant has lost its nuclear staining and appears dead at the line of union. In and around this degenerated cortex there is new bone which arises from the periosteum, endosteum, and about the haversian canals. The cortex of the transplant more distant from the line of union, which is not separated from its normal position, appears alive and unchanged.

Experiment 30. Duration 42 days. First stage. One-half length. Dog 21–11R, age 1½ months.

Macroscopical description. The healing is good but the tissues appear œdematous. The operated bone is 0.3 cm. longer, while the normal is 0.6 cm. longer than at the time of the operation. At the site of union there is a large amount of external callus, although the union is not very firm. The articular cartilage is smooth, the marrow is normal throughout the transplant, and the epiphyseal cartilage line appears normal.

Microscopical description. The articular cartilage, marrow of epiphysis and trabeculæ of the epiphysis appear normal. The epiphyseal cartilage line is slightly widened but its cellular elements are

Fig. 14 (at left). Experiment 15, 38 days, Dog 37–40R. Reimplantation of the epiphyseal two-thirds of the metacarpal bone after boring holes in the transplant. Second bone from the right, *3*, shows the implanted segment undergoing absorption. No growths since operation. Normal bone grew 0.3 cm. Compare *3* and *4* which are normally equal.

Fig. 15. Experiment 16, 44 days, Dog 33–44R. Reimplantation of one-half of the epiphyseal end of the metacarpal bone. Second bone from the left, *4*, shows reimplanted segment; 0.7 cm. shortening. Compare *3* and *4* which normally are of equal length.

normal. The metaphysis is normal and there is an exceptionally good blood supply. The marrow of the diaphysis is normal except at the line of union, where there are fibrotic and necrotic changes. The trabeculæ of the diaphysis are normal. The cortex is surrounded by a large amount of periosteal and a slight amount of endosteal new bone. At the line of union there is a heavy cartilaginous callus, chiefly of the periosteal type, which appears to arise from both the host and the transplant. The various elements of the host are normal. It is interesting to note that the only changes are near the line of union, which one would expect to be the case; as in the first stage of the experiment it is the only portion of the bone which is disturbed.

Experiment 31. Duration 89 days. First stage, one-half length. Dog 16, age 9 months.

Macroscopical description. There is no growth of the normal or the operated bone. The articular cartilage appears normal. There is a slight amount of marrow near the epiphyseal end; otherwise the marrow cavity is small and its elements are scanty. A pseudo-arthrosis is present.

Microscopical description. The articular cartilage appears thin but the cells are normal. The marrow is fatty and the cellular elements quite scanty. The trabeculæ of the epiphysis are normal. The epiphyseal cartilage line is absent so that the diaphyseal and epiphyseal marrow spaces are continuous (adult animal). The trabeculæ and the marrow of diaphysis resembles those of the epiphysis. The cortex is thin and shows some erosion on its surface. There is periosteal and endosteal callus on the stumps of both the host and the transplant, but on account of an intervening fibrous layer a pseudo-arthrosis results. The greatest amount of callus is on the side of the host.

Experiment 32. Duration 25 days. First stage, 23 days; second stage, 2 days. One-half length. Dog 20–10, age 1½ months.

Macroscopical description. The wound is infected and the transplant which is devoid of periosteum lies loose in the wound. The growth of operated bone is 0.5 cm. while the growth of the normal is 0.5 cm.

Microscopical description. The articular cartilage is of normal appearance. The marrow of the epiphysis is almost entirely necrotic. The trabeculæ show signs of degeneration. The epiphyseal cartilage line shows some shrinking of the nuclei and distortion of the cartilage-columns. There is evidence of degeneration in the metaphysis and an invasion of polymorphonuclears between the ossifying cartilage columns. The marrow of the diaphysis is likewise necrotic and contains numerous collections of polymorphonuclears. The trabeculæ are degenerating. The cortical bone stains poorly and on its outer surface there is a considerable amount of callus. These changes cannot be considered as being entirely due to the transplantation on account of the concurrent infection. The host appears normal although there is an increase of polymorphonuclear leucocytes in places.

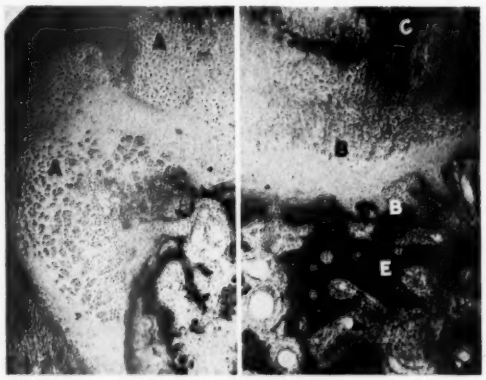

Fig. 16. Experiment 16, 44 days, Dog 33–44R. Showing new formed cartilage at the periphery of the epiphyseal cartilage line 44 days after reimplantation of one-half of the epiphyseal end of the bone. The epiphyseal cartilage line is degenerated and substituted by fibrous and osseous tissue. *AA*, New formed cartilage at the border from the perichondrium; *B* substitution of the epiphyseal cartilage line by fibrous and osseous tissue; *C* metaphysis; *E* epiphysis. Microphotograph: obj. ⅔; oc. 2 inches; B. & L.

Experiment 33. Duration 38 days. First stage, 28 days; second stage, 10 days. One-third length. Dog 37–40L, age 2 months.

Macroscopical description. There is good healing and firm union. The operated and normal bones are each 0.3 cm. longer than they were at the first operation. The joint cartilage appears normal. On longitudinal section the marrow is paler than normal except a part of the diaphysis which is of normal color. The epiphyseal cartilage line appears to be unchanged. The roentgenogram shows that the line of union is still cartilaginous.

Microscopical description. The articular cartilage is thicker than normal but the cellular elements are in good condition. The greater part of the marrow of the epiphysis is necrotic although near the epiphyseal line there is some new formed fibrous tissue containing fat and a few marrow-cells. The trabeculæ which stain homogeneously contain partially degenerated nuclei. The epiphyseal cartilage line is swollen. The osseous part of the epiphyseal ossifying cartilage layer is thin and lacks the usual appearance of proliferation. The cartilage columns in places are separated by a homogeneous fibrocartilaginous tissue and are elongated. The metaphysis shows evidence of degeneration except for a small part near the periphery. The marrow of the diaphysis is composed of fibrous tissue in which are scattered numerous regenerated marrow-elements, except in the region of the metaphysis where it is necrotic. The trabeculæ of the diaphysis show evidence of degeneration in the center and newly formed osseous tissue on the outside. The cortex is very irregular. The line of union is cartilaginous. The host, of which only a small part is present in this section, is normal.

Fig. 17. Experiment 17, 115 days, Dog 34–43L. Reimplantation of the epiphyseal one-third of the metacarpal bone. Second bone from the left, *3*, shows the implanted segment completely united. Notice absence of epiphyseal line. Growth since operation 0.45 cm. Growth of normal bone 1.2 cm. Compare *3* and *4*. The black spots on the epiphysis of *4* are flakes of lead.

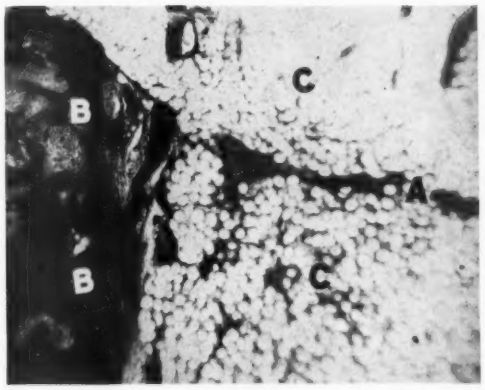

Fig. 18. Experiment 17, 115 days, Dog 34–43L. Showing the condition found 115 days after transplantation of the epiphyseal one-fourth of the metacarpal bone. *A* Small osseous remnant of the epiphyseal cartilage line; *B* Cortex; *C* regenerated marrow. Microphotograph: obj. ⅔; oc. 2 inches, B. & L.

The advanced regenerative changes in the transplant seen near the line of union are in part due to the influence of the host, to which the transplant is united, before completion of the second operation.

Experiment 34. Duration 64 days. First stage, 45 days; second stage, 19 days. One-half length. Dog 26-27, age 1½ months.

Macroscopical description. There is good healing and firm union.

In this experiment the distal part of the third medial metacarpal which measured 1.5 cm. is united to the proximal part of the second lateral metacarpal which measured 1.6 cm. Forty-five days later the wound is reopened and the two segments are found united. Their total measurement now is about 3.7 cm. thus showing a growth of 0.6 cm. After separating the tissue away from the distal part up to the line of union the wound is again closed. At autopsy nineteen days later the combined measurement of the two fragments is 3.85 cm., a total growth of 0.75 cm. since the first operation and 0.15 cm. since the second operation. The normal bone measures 4.7 cm. and shows a growth of 1.6 cm. or over twice the growth of the operated bone. Thus under the most favorable conditions for transplantation there is found to be a marked inhibition of the functioning power of the epiphyseal cartilage line.

There is a considerable amount of connective

Fig. 19. Experiment 18, 115 days, Dog 34–43R. Reimplantation of the epiphyseal two-thirds of the metacarpal bone. Second bone from the left, *4*, shows the implanted segment completely united. Compare with normal, *3*. Notice absence of epiphyseal line. Notice presence of epiphyseal line in normal bone. Growth of operated bone 0.15 cm; growth of normal bone 1.45 cm.

Fig. 20. Experiments 22 and 23, 43 days, Dog 36–42, R. and L. Autotransplantation of the epiphyseal two-thirds of the metacarpal bone. Second bone from the right, *3*, on each foot shows the operated metacarpal bones. Compare *3* and *4*, which normally are of equal length. No growth since operation on *3*. Normal growth is 0.5 cm.

tissue in the joint and the cartilage appears whiter than normal. On longitudinal section the epiphyseal part of the transplant is paler than the diaphyseal part, the latter being of normal color. The epiphyseal cartilage line is not so regular as normal and a white band is seen in the metaphyseal region. The line of union is composed of osseous tissue.

Microscopical description. The articular cartilage is normal except on one side where there is a fibrous tissue mass extending into the joint cavity. At this place there is a defect in the perichondrium and fibrocartilaginous proliferation. The marrow of the epiphysis is degenerated and in its place is fat and fibrous tissue with a few cellular elements. The trabeculæ of the epiphysis are homogeneous with cell-shadows scattered throughout. The cortical bone of the epiphysis stains poorly. In the epiphyseal ossifying cartilaginous band there is a loss of nuclear staining of the osseous part. The epiphyseal cartilage line is of about normal width but the cartilage columns are zigzagged and the cells are beginning to show degenerative changes. Beneath the perichondrium on either border there is some perichondrial new formed cartilage. The metaphyseal ossifying cartilaginous layer is well maintained. The osseous cartilaginous columns of the metaphysis are practically absent. The marrow of the diaphysis shows extensive regeneration. The trabeculæ of the diaphysis are normal except near the metaphysis where some contain poorly stained nuclei. The nuclei of the cortex in the region of the metaphysis are poorly stained but on approaching the line of union they take a deeper and more uniform stain. There is periosteal and endosteal new bone on the cortex. The line of union is not well shown in this section but there is a considerable network of new periosteal and endosteal bone in that region. The elements of the host appear normal. The marrow is of the mature fatty type. The host undoubtedly exerts a marked influence on the transplant in this experiment as is shown by the more marked regenerative changes in the part nearest to it.

Experiment 35. Duration 67 days. First stage, 45 days; second stage, 25 days. Length two-thirds. Dog 28–29, age 1½ months.

Macroscopical description. There is good healing and firm union.

In this experiment the operated bone is found to be 0.7 cm. longer than at the first operation, while at the end of the experiment it is 0.9 cm. longer. Thus, there is 0.2 cm. growth since the second operation. During the entire time the growth of the normal bone is 1.6 cm. which is practically twice

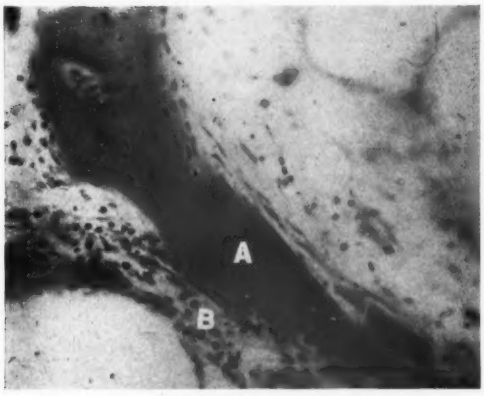

Fig. 21. Experiment 22, 43 days. Autotransplantation of the epiphyseal two-thirds of the metacarpal bone. Higher magnification of the new formed trabeculæ and marrow from the epiphyseal region of the transplant (Fig. 22). *A* New formed trabeculæ; *B* regenerated marrow-elements. Microphotograph: obj. ⅔; oc. 2 inches.

the amount of growth of the operated one (Fig. 26). This again illustrates the marked hindrance of growth that occurs under such favorable conditions for transplantation.

The joint surfaces are smooth although the articular cartilage is whiter than normal. The epiphysis is of a red color but the trabeculæ seem to be farther apart than usual. The epiphyseal cartilage line is of normal appearance except for a slight irregularity of curve. The diaphysis appears normal.

Microscopical description. The articular cartilage is normal except for a fibrous thickening at one place on the perichondrium. The marrow of the epiphysis near the articular cartilage is composed of loose fibrous tissue and marrow-elements, while the part toward the epiphyseal cartilage is more cellular and contains some fat-cells. In the center of the trabeculæ of the epiphysis are poorly stained cells, while on the periphery there is a rich cellular newly formed osteoid tissue. The epiphyseal cartilage line is of normal structure except that the cartilage columns are curved and in places are farther apart than normal. The ossifying cartilage columns of the metaphysis are almost entirely absent. The diaphyseal marrow, especially near the host, is more cellular than that of the epiphysis. The trabeculæ of the diaphysis are almost entirely regenerated. The cortex shows a considerable amount of regeneration from the periosteum, the endosteum, and the haversian canals of the transplant. This new bone is in part undoubtedly formed independently of the host, because it is just as marked at a distance from the line of union as it is in the immediate vicinity. The elements of the host are normal.

Experiment 36. Duration 80 days. First stage, 25 days; second stage 55 days. One-third length. Dog 27–28, age 1½ months.

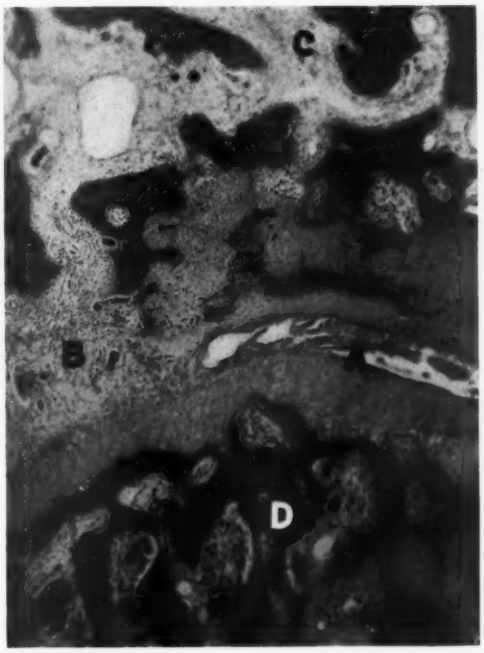

Fig. 22. Experiment 22, 43 days. Autotransplant of two-thirds length of epiphyseal end of the metacarpal bone. *A* Marked degeneration of the epiphyseal cartilage line; *B* fibrous tissue penetrating the cartilage; *C* epiphysis containing regenerated trabeculæ and marrow (see Fig. 21 for high power); *D* metaphysis fully ossified and containing newly formed fibrous tissue and marrow. Microphotograph: obj. ⅔; oc. 2 inches.

Macroscopical description. There is good healing and firm union.

The growth of the operated bone is 0.4 cm. while that of the normal is 1.6 cm. In this experiment the disturbance in growth is more marked than in the previous one. At the first operation the union is found to be incomplete which might be a factor in causing the more marked hindrance in growth. The capsule of the joint is thickened and there is some irregularity of the articular surface. The epiphyseal end of the bone is larger than normal. On longitudinal section a white homogeneous mass occupies the larger part of the epiphysis. The epiphyseal cartilage line cannot be distinguished. The diaphyseal part of the transplant is paler than normal and seems to be composed entirely of cancellous bone.

Microscopical description. The articular cartilage is quite irregular and there is a marked thickening of the joint-capsule. The articular cartilage is divided into two zones; an outer which shows well-stained nuclei in a proliferating condition and an inner zone composed of poorly stained degenerating

Fig. 23. Experiments 24 and 25, 43 days, Dog 40–37. Autotransplantation and homotransplantation of the epiphyseal one-third of the metatarsal bone (bored holes into transplant). Left foot, *A*, second bone from right, *2*, shows the marked absorption of the homotransplant. Right foot, *B*, second bone from right, *2*, shows a less degree of absorption in the autotransplant. Bones *2* and *3* should be of equal length.

nuclei (Fig. 27). The greater part of the epiphysis is composed of fibrous tissue in which are some scattered cellular elements. The epiphyseal trabeculæ appear normal. Of the epiphyseal cartilage line there remains only a small amount of cartilage beneath the perichondrium near the surface. The remainder is ossified and is continuous with the newly formed trabeculæ of the diaphysis. The marrow of the diaphysis is scanty. The elements of the host appear normal.

Experiment 37. Duration 155 days. First stage, 30 days; second stage, 125 days. Dog 25–26. Age about 2 months.

Macroscopical description. There is good healing but non-union occurred after both operations (Fig. 25). The operated bone measures 0.4 cm. less than at the time of the operation while the normal bone is 0.15 cm. longer.

Summary on the Two-Stage Autotransplantation of Varying Lengths of the Epiphyseal End of the Metacarpal and the Metatarsal Bones

The articular cartilage is well maintained in every case except in Experiment 36 where there is some evidence of degeneration of the inner layer.

The marrow of the epiphysis does not undergo any change following the first operation but immediately after the second operation degeneration occurs. It at first becomes necrotic, then fibrous, and finally is regenerated. The regeneration is similar to that which occurred in reimplantation and autotransplantation, although it takes place more rapidly.

The trabeculæ remain unchanged during the first stage but immediately following the second operation they undergo degeneration. Regeneration then takes place in the usual manner by peripheral formation and substitution with new osseous tissue.

The epiphyseal cartilage line is well maintained during the first stage and though it functionates, that property is restricted to a considerable degree. After the second op-

Fig. 24. Experiments 27 (*A*) and 28 (*B*) 143 days, Dog 29–37. Autotransplantation of the epiphyseal one-third of the metacarpal bone. Second bone from right, *2*, in each foot shows the union of the transplanted segments. Growth of operated bones 0.15 cm.; growth of normal bone, right 1.4 cm, left, 1.6 cm. Bones *2* and *3* are normally of equal length.

eration even if there is good union between the transplant and the host, its function is almost entirely lost and it undergoes a slow degeneration. The most marked disturbance in growth occurred when there was non-union at the second operation.

The marrow of the diaphysis is more rapidly and completely regenerated than that of the epiphysis. This is due to the additional marrow-cells supplied by the host.

The trabeculæ of the diaphysis degenerated after the second operation but finally regenerated by the formation of new osseous tissue beginning on their periphery. The regeneration occurs before it does in the distal part, which can possibly be explained by its closer proximity to the host.

The cortex is regenerated by means of periosteal, endosteal, and haversian new bone which is formed independently of the host. Undoubtedly the host supplies additional new bone which is of a more permanent nature than that arising in the transplant itself.

Fig. 25. Experiment 37, 155 days, Dog 25–26. Two-stage autotransplantation of epiphyseal one-half of the metacarpal bone. *A* Operated foot; *B* normal foot; *3* distal part of the third metacarpal; *4* proximal part of the fourth metacarpal. Operated bones measure 0.4 cm. less than they did at the time of operation. Normal growth 0.15 cm.

Fig. 26. Experiment 35, 67 days, Dog 28–29. Two-stage autotransplantation of the epiphyseal two-thirds of the metacarpal bone. *A* Foot operated upon; *B* normal foot. *A1* is the distal two-thirds of the third metacarpal, which was united to the proximal part of the second metacarpal *A2*. At the second operation *A1* was separated from its surrounding tissue. Growth after first operation 0.7 cm. Growth after second operation 0.2 cm. Growth of normal bone 1.5 cm.

COMPARISON OF THE TWO-STAGE AUTOTRANSPLANTATION WITH THE ONE-STAGE AUTOTRANSPLANTATION

The degenerative and regenerative processes in the articular cartilage, the marrow of the epiphysis, and the trabeculæ of the epiphysis, are very similar in both the two-stage and the one-stage experiments.

The degenerative changes in the epiphyseal cartilage line take place slower in the two-stage operation but the final result is the same; namely, complete degeneration and loss of function.

The regenerative changes in the marrow and trabeculæ of the diaphysis are more rapid in the two-stage experiment because of the greater influence of the host.

The cortex likewise is more rapidly regenerated in the two-stage than in the one-stage experiment.

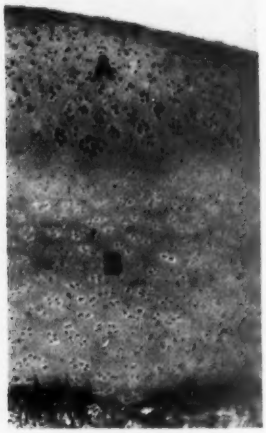

Fig. 27. Experiment 36, two-stage operation, Dog 27–28. To show the degeneration that takes place in the inner layer of the articular cartilage. *A* Outer proliferating zone; *B* inner degenerating zone. Microphotograph: obj. ⅔; oc. 1 inch; B. & L.

REIMPLANTATION OF AN ENTIRE METACARPAL OR METATARSAL BONE

Method. The entire metacarpal bone is raised from its normal bed and then immediately reinserted and anchored in place with suture extending from the neighboring tissues.[1]

Experiment 38. Duration 52 days. Dog 2, age 2 months. Medial bone.

Macroscopical description. The wound is healed without infection. There is 0.1 cm. of growth of the operated bone, while the normal bone is 0.7 cm. longer. The transplant is found in normal position and new joints have formed at the ends.

Microscopical description. There is a considerable amount of fibrous tissue in the joint cavity and slight thickening of the outer layer of perichondrium. The articular cartilage appears normal. The marrow of the epiphysis is quite cellular and shows no definite changes. The trabeculæ of the epiphysis are normal although the nuclei are not so prominent as usual. The epiphyseal cartilage line is entirely changed and only at either end beneath the perichondrium is cartilage to be found. This cartilage appears to be in an active state of proliferation. The cartilage columns are absent and in their place is a hyaline fibrous tissue which still preserves some of the parallel columnar arrangement. The metaphyseal region is occupied by a network of new bone. The marrow of the diaphysis is quite cellular. The trabeculæ of the diaphysis are partly degenerated in the center. The cortex in places stains poorly and is in close contact with the surrounding fibrous tissue.

Experiment 39. Duration 52 days. Dog 2, age 2 months. Lateral bone.

Macroscopical description. The condition is the same as in the previous experiment.

Microscopical description. The articular cartilage is partly degenerated in the inner layer. The marrow of the epiphysis appears fairly normal. The trabeculæ of the epiphysis contain nuclei shadows in their centers, surrounding which is normal bone. The epiphyseal cartilage line is represented by a hyaline band in which there are shadows of the columnar cartilage. At the periphery there is a proliferation of cartilage which extends into the diaphysis. There is only a small amount of the diaphysis in the section. A marked periosteal and endosteal proliferation is seen on one side while on the other there is a marked absorption of the cortex.

Experiment 40. Duration 107 days. Dog. 5, age 7 months.

Macroscopical description. There is good healing. No growth has occurred in the operated or the normal bone. The joint capsule is thickened. The bones appear slightly thicker than normal. The articular cartilage is not so thick as usual. The epiphyseal cartilage line is not present. There is evidence of degeneration as is seen, both in the gross specimen and in the roentgenogram. The specimen is preserved in Kaiserling's solution.

Experiment 41. Duration 113 days. Dog 4, 2d R., age 3½ months.

Macroscopical description. There is good healing. There is no growth of the operated bone while the non-operated bone is 3 cm. longer (Fig. 28). The joint cavity is in fairly good condition. On longitudinal section the epiphysis is of normal color. The epiphyseal cartilage line is absent but is present in the normal bones. The marrow of the diaphysis is scanty and the cavity is irregular in outline. The cortex is of varying thickness.

Microscopical description. The articular cartilage is irregular and in places shows defects. The synovial membrane is thickened and there is some fibrous tissue deposited on the cartilage. The articular cartilage is composed of poorly stained cells in a process of degeneration. There is a considerable amount of fibrous tissue penetrating into the cartilage substance. The marrow of the epiphysis is of the mature fatty type. The trabeculæ of the epiphysis are poorly stained. The epiphyseal cartilage line has disappeared, only a few cartilage remnants being left. The marrow and trabeculæ of the diaphysis resemble those of the epiphysis. The cortex is very irregular. The entire cortex

[1] In two subsequent experiments, one of 10 days' duration there is a necrosis of the marrow, fragmentation and fissuring of the epiphyseal cartilage line, and loss of nuclear staining of the osseous trabeculæ and cortex; in the other experiment of 20 days' duration there is a fibrotic condition with partial regeneration of the marrow, degeneration and substitution by fibrous tissue in the epiphyseal cartilage line, and the usual picture of beginning regeneration of the trabeculæ and cortex. The changes agree with those described in the other types of experiments.

stains poorly although there is evidence of both endosteal and periosteal proliferation. The general appearance of the sections indicates that a uniform slow degeneration is occurring throughout the bone in which regenerative processes had previously occurred.

Experiment 42. Duration 113 days. Dog 3R, age 3½ months.

Macroscopical and microscopical descriptions. The changes are similar to those described in the previous experiment.

Experiment 43. Duration 115 days. Dog 13R, age — old dog.

Macroscopical description. There is good healing. There is no increase in length of the operated nor the normal bones. The joint is re-formed, the capsule is thickened and the articular surface is rough. On longitudinal section it is noticed that the marrow is very scanty having been replaced by fibrous tissue. The cortex is quite irregular and appears to be eroded on its surface.

Microscopical description. The section takes a very poor stain so that it is difficult to determine the various changes. The articular cartilage appears fairly normal. The trabeculæ show little change. The marrow is fibrous and fatty. The cortex is quite irregular and there is extensive erosion in places.

Experiment 44. Duration 115 days. Dog 13L, incised, old dog.

Macroscopical description. There is good healing. Growth is absent in all bones. A spontaneous fracture has occurred 1.5 cm. from the distal end. The general appearance corresponds to the right side although there is more evidence of degeneration.

Microscopical description. The sections stain very poorly. The articular cartilage is irregular and the nuclei take a light stain. The marrow is partly fatty and partly fibrous. The trabeculæ are not arranged in a normal manner and appear degenerated in the center. The cortex shows considerable evidence of degeneration and absorption, especially on its surface.

Experiment 45. Duration 208 days. Dog 3, age 5 months.

Macroscopical description. The dog removed the dressing and the wound became infected. Only a small remnant of bone is found at autopsy.

Microscopical description. The bone remnant is encapsulated by dense fibrous tissue. The bone contains well stained nuclei. At the ends and where the periosteum is absent the osseous tissue is in close contact with the fibrous tissue. There are osteoclasts scattered between the bone and the fibrous tissue. There are some fairly normal marrow-elements enclosed within the bone.

Experiment 46. Duration 298 days. Dog 6-2R, 3rd, age 4 months.

Macroscopical description. There is good healing. The operated bone is decreased 0.6 cm. in length, while the non-operated bone is the same length as at the time of operation (Fig. 29). The joint-capsule shows a considerable thickening. On section the marrow cavity is found to be practically absent. The cortex is thickened and roughened.

Fig. 28. Experiments 41 (*4*) and 42 (*3*), 113 days, Dog 4, age 3½ months. Reimplantation of an entire metacarpal bone. Left side, *A*, shows two implanted bones undergoing absorption, Right side, *B*, shows the normal growth Wire marker indicates the original length of these bones. Growth since operation, normal 2.95; cm. of operated bones 0 cm. Notice the marked absorption of the reimplanted bones.

Microscopical description. The articular cartilage is thin and in places entirely replaced by fibrocartilage. The marrow of the epiphysis and diaphysis is very scanty and of fatty type. The trabeculæ of both the epiphysis and diaphysis are thick and take a poor nuclear stain. The epiphyseal cartilage line is absent. The cortex is quite irregular. In places the periosteum is absent and the surrounding fibrous tissue is closely adherent to the bone. The poor staining and appearance in general indicates a degenerative process. This can also be seen in the roentgenogram (Fig. 29).

Experiment 47. Duration 298 days. Dog. 6-2R2, age 4 months.

Macroscopical description. The changes correspond to those found in the previous experiment. Specimen preserved in Kaiserling's solution (Fig. 29).

REIMPLANTATION OF A SPLIT METACARPAL OR METATARSAL BONE

Experiment 48. Duration 31 days. Dog 9-4, split, age (?).

Macroscopical description. Good healing is present. There is no growth of the operated or the normal bones. The marrow is replaced by fibrous tissue and in places there is an ingrowth of osseous tissue.

Fig. 29. Experiment 46, 298 days, Dog 6–2, age 4 months. Reimplantation of entire metacarpal bones. Right, *B*, shows the implanted bones undergoing absorption; 0.6 cm. shortening since operation. No growth of normal bones. Compare *1* and *2* in *B* with *1* and *2* in *A*.

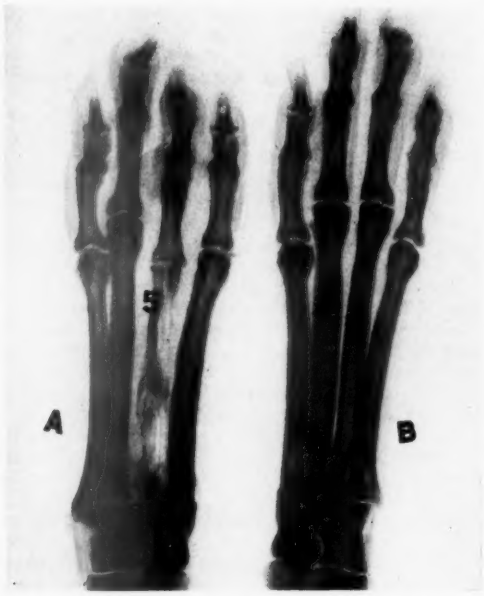

Fig. 30. Experiment 49, 223 days, Dog 18–2, age 6 months. Reimplantation of split metatarsal bone. Notice marked atrophy of implanted bone, *5A*. Compare with normal bone *5B*.

Microscopical description. The section stains poorly. The articular cartilage is of normal structure. The marrow is replaced by fibrous tissue. The trabeculæ of the epiphysis show loss of their nuclear staining. There is no evidence of the epiphyseal cartilage line. In the diaphysis there is an extensive new formation of endosteal bone. The marrow of the diaphysis is fibrous. The nuclei of the cortex stain very lightly. There is a slight amount of proliferation about the haversian canals.

Experiment 49. Duration 223 days. Dog, 18-2R, age 6 months.

Macroscopical description. There is no growth of the operated bone while the normal has increased 0.15 cm. Only a remnant of the bone surrounded by dense fibrous tissue is still present (Fig. 30).

Microscopical description. The remnant of bone possesses well stained nuclei. It is surrounded by dense fibrous tissue and in a few places the periosteum is present. Scattered along the surface and in the haversian canals are numerous osteoclasts which are aiding in the destruction. There are also some marrow-elements in the haversian canals. In the fibrous tissue away from the main bone are some particles of degenerating bone about which are many polymorphnuclear cells.

Experiment 50. Duration 237 days. Dog 14-6, age 4 months.

Macroscopical description. There is good healing. The joint capsule is thickened but the articular cartilage appears to be in good condition. The bone is firm. On section the marrow appears paler than normal.

Summary on Reimplantation of an Entire Metacarpal or Metatarsal Bone

The articular cartilage undergoes slow degeneration and in some of the experiments a substitution by fibrous tissue occurs.

The marrow undergoes an early degeneration and then regeneration takes place. This regenerated marrow persisted as long as any of the other osseous parts.

The trabeculæ degenerate early. Later, by means of regeneration beginning at the periphery they are completely re-formed. In the more advanced stages they again show degenerative changes.

The epiphyseal cartilage line undergoes progressive and complete degeneration. There is some cartilage regeneration beneath the perichondrium at the edges but this does not persist.

The marrow and trabeculæ of the diaphysis undergo the same changes as they do in the epiphysis.

The cortex at first degenerates and then is regenerated by new bone formed from the periosteum, endosteum, and about the haversian canals. As the observation did not extend beyond 298 days, it is hard to say definitely the fate of this bone; but from the various pictures presented it seems as though this newly formed bone again degenerates and finally entirely disappears or only a small remnant remains.

There is always complete failure of growth after reimplantation of an entire bone.

AUTOTRANSPLANTATION OF AN ENTIRE METACARPAL OR METATARSAL BONE

Method. The entire metacarpal or metatarsal bone is raised from its bed and interchanged with a corresponding bone of the opposite foot.

Experiment 51. Duration 36 days. Dog 17L, split at distal end, age 9 months.

Macroscopical description. There is no growth of the operated bone, while the normal increase is 0.4 cm. The joint-capsule is thickened, and the cavity contains turbid fluid. The articular cartilage is rough. The distal end of the bone appears enlarged. The epiphysis is composed of a gelatinous cartilage looking material. The marrow-cavity contains soft degenerating marrow. The cortex is irregular and thickened.

Microscopical description. The joint-cartilage shows a different degree of staining in the outer and inner parts, in the latter the nuclei stain poorly. There is a fibrous tissue substitution of the marrow of the epiphysis which contains collections of polymorphonuclear leucocytes. The trabeculæ of the epiphysis are composed of a homogeneously stained center without nuclear stain, about which is newly formed osteoid tissue. The epiphyseal cartilage line is almost entirely absent and a fissure extends through this region. The metaphyseal cartilage columns are scanty and appear to be degenerating. The marrow of the diaphysis is fibrous and the trabeculæ show marked evidence of degeneration. The cortex is composed of a homogeneous nonnuclear containing tissue about which there is some newly formed bone, but there is more evidence of absorption.

Experiment 52. Duration 36 days. Dog 17R, split entire, age 9 (?) months.

Macroscopical description. The bone is 0.5 cm. shorter than at time of operation while the normal bone is 0.4 cm. longer. Joint cartilage is rough, distal end of bone necrotic, and epiphysis absent.

Microscopical description. On cross section the marrow cavity is seen to be filled with fibrous tissue. The nuclei of the cortex stain poorly and the architecture is not so regular as normal. One one side there is a considerable amount of periosteal new formed cartilage and osteoid tissue.

Experiment 53. Duration 89 days. Dog, 10-5L, age 3½ months.

Macroscopical description. The healing is good. The operated bone is 0.6 cm. shorter than at the time of operation, while the non-operated bone is 0.1 cm. longer. The marrow appears normal. The epiphyseal cartilage line is not distinguishable.

Microscopical description. The articular cartilage on one side appears fairly normal while on the other side it is practically replaced by fibrous tissue. The marrow and trabeculæ of the epiphysis are normal. The epiphyseal cartilage line is almost entirely absent, only a small band of ossifying cartilage is present. This band appears nearer to the articular cartilage than normal, as if there is a collapsing of the epiphysis. The marrow of the diaphysis is normal. The trabeculæ are normal although some contain what appears to be dead bone in their centers. The outer surface of the cortex is very irregular and eroded, although the general structure of the bone is normal.

Experiment 54. Duration 89 days. Dog 10-5R, age 3½ months, incised.

Macroscopical description. In this experiment holes are bored into the bone at various places. There is 0.5 cm. shortening of the operated bone. On section there is a large cartilaginous mass in the region of the epiphyseal cartilage line. The proximal end of the bone is smaller than normal.

Microscopical description. There is a mass of fibrous tissue extending into the joint. The perichondrium is thickened and in some places the cartilage is pierced by fibrous tissue. The cartilage that remains shows a peculiar arrangement of the nuclei and it is difficult to determine whether it is degenerating or regenerating. The marrow and trabeculæ of the epiphysis and diaphysis appear normal. The epiphyseal cartilage line is represented by a thin band of ossifying cartilage, at one end of which is a large amount of perichondrial fibrocartilaginous tissue, which is undergoing ossification. The cortical bone is of normal structure although there is extensive erosion on its surface.

When this experiment, in which holes are bored into the transplant, is compared with the previous one, which was left intact, it is noticed that the various parts of the latter are best maintained.

Experiment 55. Duration 91 days. Dog 8-3L, age 6 months.

Macroscopical description. The transplanted bone is 0.3 cm. shorter than it was at the time of the operation. There is only 0.2 cm. growth in the normal bone. There is some thickening of the

joint-capsule and irregularity of the articular surface. On section the marrow-cavity is found to be occupied by cancellous bone in which are scattered marrow elements. The cortex is thickened, irregular, and quite dense; thus giving the bone a larger and more irregular appearance than normal.

Microscopical description. A cross section at the distal end shows an abnormally shaped marrow-cavity containing fairly normal marrow. The trabeculæ are more numerous than normal and in the centers of some there is degenerated bone. The cortex, the nuclei of which are well stained, shows a distortion of the haversian systems and about the outer surface, which is rough, are many osteoclasts. The periosteum has lost its normal appearance so that the surrounding fibrous tissue penetrates into the cortex. The proximal end is similar, with the exception that the marrow is not so cellular.

Experiment 56. Duration 109 days. Dog 1-L, 5 months, forefoot.

Macroscopical description. Only a small remnant about 2 cm. long of the distal part of the transplanted bone remains. There is no growth of the normal bones.

Microscopical description. There is dense fibrous tissue surrounding the piece of bone. The bone contains mature marrow and trabeculæ of normal appearance. The cortex is irregular, and fibrous tissue penetrates the bone substance in some places. There are numerous osteoclasts scattered about the periphery. There is no distinct periosteum present.

Experiment 57. Duration 109 days. Dog 1-1L, age 5 months, hind foot.

Macroscopical description. There is no increase in length of the transplanted or the normal bones. The articular surface is rough and at its distal end the bone is fused with the adjoining bones.

Microscopical description. On cross section of the distal end there is a normal piece of bone adherent to the transplant. On comparing the two, the transplant is much more irregular in outline and in arrangement of the haversian systems. The periosteum has lost its distinguishing structure and the fibrous tissue is in intimate contact with the bone. Many osteoclasts are present. The marrow and trabeculæ are of normal structure but likewise irregularly arranged.

Experiment 58. Duration 255 days. Dog 12-L, old dog.

Macroscopical description. The articular cartilage appears almost normal. On longitudinal section the marrow-cavity is irregular and the marrow appears paler than usual. The general appearance is one of slow degeneration.

Microscopical description. The articular cartilage is regular in outline but the nuclei take a pale stain. The marrow toward the epiphysis is of the mature fatty variety, while in the diaphyseal part it is replaced by fibrous tissue. The trabeculæ for the most part contain poor staining nuclei. In the cortex the nuclei take a poor stain, excepting those immediately beneath the periosteum, where there appears to be newly formed osseous tissue.

Summary of Autotransplantation of an Entire Metacarpal or Metatarsal Bone

As far as can be ascertained from this incomplete series there appears to be more degeneration in the case of young animals than in the older animals.

In the young animals the articular cartilage shows marked degeneration and substitution by fibrous tissue. In the old animals the articular cartilage is well preserved even at 255 days.

The marrow at first degenerates and then becomes fibrous. Later it regenerates and persists for a considerable length of time.

The trabeculæ degenerate at first as is seen in the 36-day experiment and then regenerate by a process of peripheral new formation.

The epiphyseal cartilage line undergoes a progressive degeneration. There is some new cartilage formed during the early stages, beneath the perichondrium at either border but this eventually disappears.

The cortex at first loses its nuclear staining, then regenerates and finally undergoes a slow absorption. The periosteum seems to disappear, and the fibrous tissue and osteoclasts gradually absorb and replace the bone.

COMPARISON OF REIMPLANTATION AND AUTOTRANSPLANTATION OF AN ENTIRE METACARPAL OR METATARSAL BONE

The articular cartilage shows more rapid and extensive degeneration in young animals after autotransplantation of an entire bone than after reimplantation. In older animals the difference is not so evident nor is the process so rapid.

The marrow in both cases degenerates at first and then becomes fibrous and finally regenerates. The processes are about the same in reimplantation and in autotransplantation.

The degenerative processes of the epiphyseal cartilage line are the same in both reimplantation and autotransplantation, a gradual complete progressive degeneration

with only a slight temporary regeneration at the periphery beneath the perichondrium.

The cortex is similarly affected in both reimplantation and autotransplantation. At first there is degeneration and then regeneration, after which the periosteum loses its structure and a slow absorption occurs throughout the entire bone. Though sufficient time has not elapsed in these cases, the indications are that there would be complete disappearance of the transplants if a longer period were allowed to elapse before terminating the experiment. The transplants from older animals were able to withstand the degenerative processes better than those from younger animals.

There is complete failure of growth in both reimplantation and autotransplantation of an entire metacarpal or metatarsal bone.

The splitting or incising the bone did not favor the transplantation, on the contrary it hastened the degeneration.

DISCUSSION AND REVIEW OF THE LITERATURE

Helferich (2), in some experiments performed on rabbits in 1899, in which he reimplanted the lower epiphyseal cartilage line of the ulna, came to the conclusion that the epiphyseal cartilage line, under favorable conditions, retained its property of producing length growth although he noted there might be a lessening of that function. Enderlin (3), who made the microscopical studies of these preparations decided that the epiphyseal cartilage line retained its vitality to a large extent. The parts near the periphery were best maintained, while those at the center showed evidence of degeneration.

Zoppi (4) found in autotransplantation of the epiphysis a regular healing in and formation of new bone but in heteroplastic transplantation there was a complete failure.

Galcarzi (5) found in both autotransplantation and homotransplantations calcification of the epiphysis and complete loss of function.

Rehn and Wakabayashi (6), from a series of experiments on two-months-old rabbits in which they performed homoplastic transplantations of the head of the radius concluded that the epiphyseal cartilage fully maintained its histological structure and function after such transplantations. Their experiments are open to criticism because they do not rule out the greater growth that takes place from the distal epiphysis of the radius. In their microscopical descriptions they mention certain degenerative changes occurring in the epiphyseal cartilage line at 28, 31, 35, and 42 days after operation which is before the normal time for ossification of the epiphyseal line in rabbits (fourth to fifth month). In the present article the results in autotransplantation are less favorable than in reimplantation. It is more than likely that the degenerative changes would be still more marked in homoplastic transplantation and that the results would be quite contradictory to those of Rehn and Wakabayashi. Obata, who performed a series of experiments exactly similar to those of Rehn and Wakabaysahi, does not agree with their functional nor their microscopical findings.

During the same year, 1912, Axhausen's (7) article appeared in which he reported the results of his experiments on young rats and rabbits. He transplanted the lower fourth of the femur from a growing rat to the subcutaneous tissue of another rat. He found some degeneration of the inner layer of the articular cartilage at the sixth to twentieth day after which there was regeneration. The marrow of the epiphysis and diaphysis at first degenerated, then became fibrous and at a very late period was regenerated in the ephiphysis. The trabeculæ at first degenerated and then regenerated. The epiphyseal cartilage line showed in the early stages a shrinking of cells and at 20 days only the peripheral parts remained alive. In the later stages aside from a slight proliferation near the periphery the entire line was substituted by fibrous tissue. The cortex showed an extensive degeneration up to 30 days, but in the older stages there was considerable regeneration. In a similar set of experiments on rabbits the results corresponded quite well to those found in the rats. In another group of experiments thin sheets of articular and epiphyseal cartilage of the femur of rabbits were transplanted under the skin on the back of another animal. The marrow

was substituted by fibrous tissue except beneath the articular cartilage and near the surface. The bone trabeculæ appeared to undergo degeneration with very little evidence of regeneration. The articular cartilage showed in the later stages, a substitution of the dead inner layer by a proliferation from the perichondrial layer. He also transplanted the patella, either intact or split in two pieces, from one rabbit to the subcutaneous tissue of another rabbit. The bone showed shrinking of nuclei at 24 days, empty cells at 45, 50, and 70 days. There was an early necrosis of the marrow and complete degeneration at 24 days. At 50 days there was beginning organization which was completed at 70 days. The inner layer of the articular cartilage showed a beginning shrinking of the cells at 10 days which was more marked at 38 days. At 50 days there was some proliferation of the cells and at 70 days there was evidence of resorption of the cartilage. In the cases where the patella was cut into two pieces the cartilage showed some necrosis on the surface due to the trauma.

While the present work was being completed the following articles appeared and they will be reviewed in the order of their publication.

Von Tappeiner (8) performed three reimplantations and eight homotransplantation experiments on dogs, at the ages of one and one-half and four and one-half months. In the reimplantations he found no changes in the articular cartilage. The marrow of the epiphysis and diaphysis showed fibrous changes at first, after which regeneration occurred. The trabeculæ at first degenerated and were then reformed. There were practically no changes in the epiphyseal cartilage line even after six months. The cortex at first degenerated and then was regenerated. There was no disturbance in the normal growth. These findings in reimplantations are entirely at variance with those of the present article; both as regards the normal microscopical appearance of the epiphyseal cartilage line and the normal longitudinal growth of the bones which he reports. As his experiments were performed under exactly the same conditions, it is difficult to explain or offer any reason for such wide variation in the results. His microscopical descriptions on homoplastic transplantations correspond closely to the autoplastic experiments described in the present paper. He ascribes some power of the epiphyseal cartilage line to increase in length even after homotransplantation, again disagreeing with the findings of the author.

Obata (9) has made a very complete study of the transplantation of the epiphysis in his work on joint transplantation. He performed reimplantations, autotransplantations, and homotransplantations of the metatarsophalangeal joint either with a part of or the entire metacarpal and phalanx. He found a disturbance in growth in every instance, the greatest being in the case of homoplastic transplantations. The transplanted joint cartilage maintained its normal form but appeared cream white and in later stages erosions appeared on its surface. The union of transplant with the host was normal in every case except in homoplastic transplantations where there was a pseudo-arthrosis. In general the above macroscopic findings agree with those of the present investigation except that Obata did not find such a marked failure of length growth in his reimplantations. In Obata's microscopical findings on reimplantation, he describes degenerative changes in the articular cartilage as early as 9 days which were more marked at 35 days; then regenerative changes at 50 days and again degeneration in the middle part, at 70 and 100 days. At 104 days he says it is in normal condition. It is difficult to analyze these changes and he offers no explanation for the variations in the processes. He also described a progressive degeneration of the epiphyseal cartilage line until the fiftieth day, after which there occurred a partial degeneration followed by a regeneration. He ascribed almost normal functional properties to this regenerated epiphyseal cartilage line. At 70 days he described an extensive degeneration of the epiphyseal cartilage line. It is difficult to explain the discrepancies in his findings in that there was an extensive degeneration at 35 and 70 days while at 50 days the cartilage was so well maintained. It is possible that

under some especially favorable circumstance the transplanted epiphyseal cartilage line did not undergo the usual rapid degeneration as in the other cases. In comparing Obata's findings on reimplantation with those of the present work there is a considerable uniformity, except that he describes extensive degeneration of the articular cartilage while in these experiments the articular cartilage proved to be the most resistant of any of the transplanted tissues. This difference might be due to the fact that he transplanted the entire joint with the intact capsule, which perhaps prevented the early inflow of nourishing fluids as is possible in the case where only one-half of the joint is utilized. Neither is there an agreement as to his statement that the epiphyseal cartilage line can regenerated so as to continue the length growth of the transplanted bone. In the autotransplantation he likewise describes much more extensive changes in the articular cartilage than is found in the present work. Otherwise the changes correspond fairly well to the changes that are described in this series of experiments. In Obata's homoplastic experiments he found changes to be more extensive in the cartilage than in reimplantation or autotransplantation, with very little evidence of regeneration. There was also less tendency to regeneration of the marrow, trabeculae and cortex. In case of non-related animals the degenerative processes were more rapid and extensive. In the homoplastic transplantation of the head of the radius he found the same degenerative changes throughout the transplant as in the other cases. The epiphyseal cartilage line underwent a progressive degeneration with practically no regeneration. Thus, he does not agree with Rehn and Wakabayashi who performed similar experiments and described complete retention of structure and function of the epiphyseal cartilage line.

Heller (10) performed reimplantations and homotransplantations of the distal epiphysis of the ulna of rabbits and goats. He found the least amount of shortening in reimplantation, while the greatest amount was in homoplastic transplantations in non-related animals. He concluded that a practical use of the epiphyseal cartilage line with a more or less large piece of bone attached could not be utilized in reimplantation and certainly not in homotransplantation. He said that in reimplantations there was some regeneration of the epiphyseal cartilage line and a not inconsiderable amount of bone apposition, but nevertheless the bone growth was retarded. In homoplastic transplantation he found some perichondrial regeneration but that there was no tendency for a physiological utilization of this in the epiphyseal cartilage line. The larger the animal the less favorable were the results and the more rapid and extensive the resorption; even to complete disappearance of the transplant. He predicted that it might be possible by using very thin pieces of the epiphyseal cartilage line to obtain some successful results, and in a short note at the end of his article intimated that he had obtained favorable results by the use of thin sheets in autotransplantation. The findings of Heller agree fairly well with those described in this paper, except that he reports more or less growth after reimplantations. The use of the distal end of the radius and ulna, on account of the bending of the extremity does not offer so favorable an experimental method as does the use of the metacarpal or the metatarsal bones.

Minoura (11) transplanted the metatarsophalangeal joints, either intact or split longitudinally, of two-months-old rabbits, into the back, subcutaneous tissue, liver, or abdominal cavity of the same or different animals. In some cases the joint was placed in Ringer's solution before transplantation or was removed from a dead animal. These experiments do not correspond to those of the present work because the transplant was placed under unnatural conditions, but on account of a certain agreement of the early histological changes they will be reviewed. He found that the transplanted joint became encapsulated by the tissue of the host and that the healing was always the same whether it was in the muscle, subcutaneous tissue, or abdominal cavity. In the longitudinally split bone the organization took place more quickly than in the entire bone and there was little difference in the processes if the joint was

allowed to remain in Ringer's solution before transplantation. The joint cartilage remained intact for a considerable time and always showed a cartilage-cell regeneration on the periphery. The marrow degenerated and was substituted by fibrous tissue and later by fat. The trabeculæ of the epiphysis degenerated and later were substituted by new-formed bone, which however was not permanent. The epiphyseal cartilage line underwent necrosis and absorption, only the parts of the proliferating zone near the periphery showed multiplication of the cartilage-cells. The periosteum always showed new bone formation in the inner layers but the new-formed tissue finally underwent absorption. In these experiments there was no possibility of the bone of the host playing a part in any of the regenerative processes. The findings agree very well with those of the present work except that in Minoura's experiment there was not the extensive regeneration and there was a lack of permanency of the new-formed tissue. Thus it shows that there are certain regenerative processes that can take place in a transplant without the aid of the host, but in order to have lasting qualities some additional elements from the host are necessary. The changes in homoplastic transplantation were similar to those of autotransplantation, although they were not so marked nor so permanent. In none of the experiments was there any increase in the length of the bone after transplantation.

Gill (12) reports eleven experiments performed on full grown animals in which he made autotransplantations of the entire metatarsal bones. Infection occurred in most of his experiments, but in spite of that fact, he says five of the transplanted bones were practically normal at the end of eight months. He found no evidence of dead bone on microscopic examination in those experiments in which there was only slight infection. In comparing Gill's results with those of similar experiments in the present paper there is a considerable variation in the findings. In practically every case, in the present experiments, there was macroscopic and microscopic evidence of degenerative changes after the transplantation of an entire bone. The changes took place earlier and were more extensive in the young animals.

SUMMARY

1. The epiphyseal cartilage line ceases to functionate after reimplantation and autotransplantation, either when transplanted by itself or with a small or a large piece of adjoining diaphyseal or epiphyseal bone, or even when transplanted as an entire intact bone. The longitudinal growth ceases in every case. The first change after transplantation consists of a fragmentation of the cartilage columns near the epiphyseal ossifying layer. Later there is a disappearance of these cells. Then there is fibrous substitution of the remaining parts, and finally ossification occurs as in the adult animal. The only evidence of regeneration is near the periphery beneath the perichondrium, which part seems to retain its property of producing cartilage. This new cartilage possesses none of the length-producing functions of the normal epiphyseal cartilage line. The epiphyseal cartilage line is the least transplantable of any of the components of bone.

2. The articular cartilage undergoes practically no changes after reimplantation. In autotransplantation there occurs at times evidence of degenerative and regenerative changes. In some of the experiments of longer duration there is a partial substitution by fibrous tissue. The articular cartilage offers the greatest possibilities of successful transplantation of the various parts of a bone.

3. The marrow of the transplant appears to undergo an early complete necrosis. It is possible that some of the cells persist because of better conditions for nourishment, or have a greater resistance, and are later the source for the regeneration of the marrow. After the necrosis of the marrow the spaces are filled with fibrous connective tissue. At a still later period scattered marrow-cells are found in the fibrous tissue and there is then a gradual re-formation of the marrow. The exact method of regeneration cannot be definitely determined. Whether it bears any relation to the newly formed capillaries or arises from the persisting marrow-cells of the transplant, is difficult to ascertain.

4. The trabeculæ show early evidence of degeneration as is indicated by the loss of staining property of the nuclei. The first indication of regeneration is seen on the periphery, where a layer of osteoblasts are found. The later stages show a proliferation of these cells to form osteoid tissue which gradually replaces the old bone to form the new trabeculæ. It is impossible to determine definitely the origin of this new tissue but it is probable that the osteoblasts on the surface of the trabeculæ on account of better conditions for nourishment have persisted, and with the re-establishment of the capillary blood supply are able to proliferate and re-form the bone; or they might bear some relation to the fibroblasts. The process is the same in both reimplantation and autotransplantation of parts of bone or entire bones.

5. The cortex shows an early loss of nuclear staining. Later there takes place a new formation of osseous tissue from both the periosteum and the endosteum, and, with a limited amount of new osseous tissue in the region of the haversian canals, the cortex is completely regenerated. Even in the transplants that are in contact with the bone of the host, the new tissue is formed independently of that source. It seems as though this new bone is lacking in some property by which it may continue to exist, and, in order to endure, some additional stimuli or osseous elements are necessary to establish the premanency of the transplant. This additional factor might be in the nature of certain stimulating fluids from the normal bone or an emigration of definite osseous-forming cells.

6. Following the first operation in the two-stage autotransplantation of the epiphyseal end of a bone, there is a considerable disturbance in the function of the epiphyseal cartilage line, even though the epiphysis is not separated from the surrounding tissue. The loss of growth is most likely due to the interference with the minor vascular supply from the diaphysis to the epiphyseal cartilage line. After the second operation in which the epiphysis is separated from the surrounding tissue and the epiphyseal vessels destroyed there is a complete cessation of growth. This loss of function occurs in spite of the fact that the transplant is united to the host and that a part of the diaphyseal blood supply is re-established. The importance of the direct vascular supply to the epiphyseal cartilage line is forcibly demonstrated in this experiment.

7. The vitality of the various components of bone after transplantation is directly related to the ability of that part to withstand the loss of its vascular supply. The least dependent the part is upon its blood supply the greater is the possibility of a successful transplantation, as is the articular cartilage; while, on the other hand the more dependent the part is upon its vascular connections the less likely is the possibility of a successful transplantation, as is the epiphyseal cartilage line.

8. From these experiments and the results in general on transplanted bone the following conclusion is offered regarding the fate of bone after transplantation. Although each part of transplanted bone possesses the power to regenerate independently and without the aid of neighboring bone, this autonomous newly formed tissue does not possess that property which is necessary for a continued existence, and it will ultimately entirely disappear. Some additional stimulus is needed and such conditions are only obtained when the transplant is in direct contact with normal growing bone. Therefore, when there is failure of such connection the transplanted bone at first shows evidence of regeneration but if a sufficient time is allowed to elapse, it will ultimately entirely disappear. However, if it is united with the cut surface of normal bone it will continue to live because certain necessary additional stimuli and new elements will be supplied by the host. It is possible that certain chemical or physiological stimuli are supplied by the living intact bone, after which the regenerated bone on account of these additional factors is able to persist permanently. Undoubtedly some definite osseous elements from the bone of the host invade the transplant and either replace the temporary bone or give to it certain requisites for its perpetuation. Although function may play a factor in the development of bone it is not of prime importance in determining the permanency

of that tissue. The differences of opinions of the various investigators is in part due to the failure to allow sufficient time to elapse before drawing final conclusions, as well as to take into account the influence of different environmental conditions on the transplant from both young and old animals.

In conclusion, I wish to extend my thanks to Professor Ophuels, of the Pathological Laboratory, under whose guidance the above work was performed, for his interest and suggestions; also, to thank Professor Blaisdell of the Surgical Laboratory for his assistance in the operative work.

Since this article was submitted for publication the following paper[1] has appeared: "Neue Experimente zur Frage der homoplastischen Transplantationsfahigkeit des Epiphysenknorpels und des Gelenkknorpels." He gives the results obtained from sixteen homoplastic transplantations performed upon the upper epiphysis of the radius of rabbits. He reports two successful instances, one of which was not only anatomically but physiologically efficient. He is unable to explain the variation in the results, but suggests that it might be on account of the less poisonous reaction of the body fluids. Like all experiments on the upper epiphysis of the radius they are open to criticism, and a careful analysis of his descriptions are not entirely convincing as to the absolute success of these experiments.

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TRAUMAS OF THE BACK AND SPINE[1]

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In my experience with traumatic surgery I have met with no more interesting series of cases than as represented by the title of this paper; and having frequently to pass judgment upon the seriousness of such injuries, the responsibility attached thereto is not always a light one. The actual conditions present are often so veiled by exaggerated imaginary or simulated symptoms that one must be very careful in making a diagnosis and prognosis not to overlook or underestimate serious injuries or to consider too seriously the minor ones.

This paper is based upon the records of 758 cases. Of these, 51 were under my personal observation, while the balance are collected from my file of reports from men associated with me in railroad surgery. I have been in close touch with the conditions in all of the cases so reported, have received frequent reports in the more serious ones, have examined many of them, and have been able to direct the line of treatment. The list includes only those injuries which have been diagnosed as a contusion or sprain, together with their complications. No cases

[1] Read before Chicago Surgical Society, March 3, 1916. (For discussion, see p. 366.)

are included except where the period of disability has exceeded one week, and I have also excluded all cases known to be complicated by a fracture or dislocation.

By a contusion we mean those direct traumas received either over the spine itself or, as more frequently happens, to one side of it and involving the muscles and other soft tissues of the back. Looked upon by many as injuries of minor importance from which the victim promptly recovers, they are nevertheless in some instances serious in character and the disability produced is an extended one.

The contusions are included with sprains because it is almost impossible at times to distinguish one from the other, particularly so when the contusion has been directly over the spine. In those cases not seen by me I have as a rule accepted the diagnosis as made by the attending surgeon, but my personal experience with this class of cases leads me to believe that the diagnosis has been incorrect in many instances and that cases reported as contusions are often sprains, and some of the so-called sprains are no more than contusions.

In contusions the trauma varies from a moderate bruising of the soft tissues to a laceration of the dorsal muscles, a stretching or tearing of muscular attachments to the spine, injury to spinal nerves, and injury to internal organs, as the kidney. In the milder cases there may be no external evidence of an injury, while in more serious ones there will be a swelling, with or without discoloration, and large deeply lying hæmatomata may form from extravasated blood and serum. Rarely a groove or depression may be felt between divided muscle-bundles.

From a total of 277 cases, 83, or 29 per cent, were located in the lumbar region; 45, or 16 per cent, in the dorsal region, and 10 per cent occurred in both the dorsolumbar and sacral regions. In 62, or a little over 20 per cent, the location was not specified and from the figures above it is proper to assume that a majority of these occurred below the dorsal region. A period of disability in the mildest cases in this list averages from two to three weeks, while a disability of from two to three months is not at all uncommon. Contusions in which recovery is more delayed and which run from four to six months or a year have some complication as sprain, a possible fracture, nervous symptoms, or there is intent on the part of the patient to try and secure a large settlement.

A sprain may be considered as a bending or twisting of the spine and a stretching of the spinal muscles and ligaments to a point beyond their physiological range of motion. Constructed and supported as it is, the spine will withstand a considerable amount of jarring and bending without symptoms of injury following. Its elasticity is dependent upon the articulations between the vertebræ, the intervertebral cartilaginous discs, or buffers, the spinal and intervertebral ligaments, and the spinal muscles. The elasticity and pliability present lessen very materially the shock produced by all kinds of traumatism. The cord itself is further protected against injury by being suspended within the spinal canal, covered by its layer of membranes and the cerebrospinal fluid, and supported to a further extent by the spinal nerves. The space between the dura and the walls of the canal is filled with loose cellular tissue and the venous sinuses. The cord can therefore be injured only by a narrowing of the bony canal as by fracture or dislocation, by hæmorrhage within the canal or in the cord itself, or produced by a shock or strain of some character. From the latter cause arises the condition described as spinal concussion, a trauma defined by Dr. Murphy as an impairment or loss of function of the spinal cord due to an injury which is not sufficient to produce gross anatomic changes. Though denied by many surgeons, I am convinced that this condition does not infrequently occur as a result of some contusions and direct sprains.

Sprains are the result of either a direct or an indirect force. They occur directly, as in contusions, from a fall or blow, and indirectly from falls upon the feet or buttocks, from carrying heavy weights upon the head or shoulders, from jumping, slipping, twisting of the spine, and from over exertion in the act of lifting, pulling or pushing.

The spinal muscles are undoubtedly at fault in a large number of the cases, about 80 per cent as near as I have been able to estimate, while the articulations and ligaments are involved in the remaining 20 per cent. This relative proportion is probably due to the fact that many of the more severe sprains are often complicated by a fracture, and such cases are classed as fractures. The sprains have been grouped according to their origin from direct or indirect causes, it having been found impossible to separate satisfactorily those involving only the spinal muscles from those affecting also the articulations and ligaments. One point of differentiation, which cannot, however, be too much depended upon, is that pain upon straightening the spine indicates a muscular involvement, while pain in bending the spine indicates involvement of the ligaments. Although the mobility of the spine is greatest in the cervical region, where the vertebræ are smallest and there is less muscular protection to them, sprains occur most frequently in the lumbar region, where the vertebræ are larger, stronger, and more protected.

Out of the 481 cases classed as sprain, 420, or 87 per cent, were due to indirect causes, and of these, 200, or 47 per cent, involved the dorso-lumbar and lumbar region. Of 61 cases due to direct trauma, 29, or 47 per cent, involved the same region. If we add to these a proportionate number of those cases in which the locality was not specified we have involving this region 58 per cent of all the cases. Cervical sprains, the next in frequency, were reported but 31 times, twice as due to direct and 29 times from indirect cause. Direct contusions and sprains in the region of the coccyx were reported 20 times, and a few of those developed a coccyodynia which persisted for months. Those sprains involving the muscles alone are usually caused by lifting, pulling, or pushing too heavy weights, carrying loads upon the head or shoulders, or due to a sudden twisting of the body as from slipping. The ligamentous sprains are usually the result of a fall upon the feet or buttocks or upon the back and shoulders. Numerous cervical sprains have occurred in sleeping cars, where as a result of sudden stopping of a train one has been thrown up against the head-board of the berth, thus causing a forced flexion of the head.

The symptoms in contusions and sprains are similar and as has been stated one cannot always be distinguished from the other. In the milder cases there is localized pain and tenderness with some muscular rigidity, more marked on one side of the spine in contusions and involving both sides in sprains. In both the pain is much less when the back is kept at rest and is increased by all bending or twisting movements. There is more muscular rigidity, or muscular spasm, in sprains, this being Nature's method of enforcing rest to the strained ligaments and articulations. Some of the rigidity is voluntary from "fear of pain," as has been described by Page. The patient assumes at all times the position which gives him the greatest relief from pain, and in all attempts to rise from a sitting position or in lying or sitting down uses the arms and legs to assist in the movement while holding the back very rigid. The reflexes of one or both legs are usually increased. Hyperæsthesias and paræsthesias are often present. Disturbances of the bowels and bladder are not infrequent in both contusions and sprains. In this series 22 patients complained of increased frequency or inability to urinate and in 17 cases bloody urine was passed for from a few hours to several days. Eighteen cases involving the lumbar and lumbosacral regions complained of particular pain over one of the sacro-iliac articulations.

Contusions and sprains are frequently so complicated by other symptoms of nervous disorder, paralyses, etc., that our chief concern may be regarding the complication rather than injury itself. In the series 27 cases developed a traumatic neurosis, 3 developed hysterical paralyses, one a traumatic spondylitis, and an epileptic convulsion occurred in one case one month after an injury to the back though the previous history was entirely negative. Eleven cases were classed as malingerers. Two cases suffered from hæmorrhage, one extradural and the other within the cord, as a result of strain due to lifting.

The period of disability in sprains averages

longer than with the contusions. The muscular sprains are usually recovered in from two to three weeks. The milder ligamentous sprains disable one from four to six or eight weeks while the severe type will average from four to six months. In some cases pain is present off and on for several years. Those complicated by a traumatic neurosis average from six months to a year or longer.

In making a diagnosis great care should be taken not to overlook a more serious injury, as a fracture or dislocation. This has been done in a number of cases of which I have record. X-ray plates must be obtained in all doubtful cases, and these will at times show a fracture or other lesion which cannot be positively demonstrated in any other way. Owing to the great danger in handling a patient suffering from fracture or dislocation, we must exercise great care in conducting the examination. A valuable point in differentiating sprains from dislocations, particularly in the cervical region, is that in sprains all the normal movements can be obtained, though very painful, while with a dislocation certain movements are not possible, but the effort to make them is not particularly painful. For this reason all manipulative movements should guard against the danger of inflicting more damage to the cord structure in case a dislocation or fracture is present. The necessity of such care is emphasized by a case reported to me several years ago as a sprain of the back. Several days after receiving the report a supplemental report stated that upon attempting to turn the patient upon his side in order to make a more careful examination a sudden marked deformity occurred, due to a fracture-dislocation at the level of the seventh dorsal vertebra. No difficulty should be met with in diagnosing the ordinary contusion or sprain, but many errors are made in separating the muscular from the ligamentous sprains.

The prognosis depends upon the actual injury sustained and the complications which arise. The period of disability is no true index to the severity of the injury, and nervous symptoms may be present in minor as well as severe cases. One must ever be on the lookout for malingerers or damage seekers. The settlement of a claim for damages often has a most beneficial psychic effect upon a patient and recovery takes place rapidly, though there may be nothing in the case to suggest an intentional exaggeration of symptoms.

I shall make no attempt to describe treatment of these cases in detail. Contusions should be treated the same as when they occur in other regions. In general the treatment of sprains depends upon whether the muscles are at fault or if the ligaments and articulations are also involved. Those cases in which the muscles alone are affected should be given rest for a few days, followed by massage and a gradually increasing amount of gymnastic or "setting up" exercises. The ligamentous sprains require rest and the spine should be supported by adhesive strapping or other more effective means to secure this. Except for pain and tenderness at first, massage and moderate exercise of a strained muscle or group of muscles should give relief, but if after such a treatment the pain is increased and no temporary relief is felt, then we should assume that the ligaments are involved and treat accordingly. Complications should be treated according to their symptoms. Environment, sympathy of friends and members of the family, visions of permanent disability or invalidism, business worries, etc., all tend to bring on or increase nervous symptoms and thus delay recovery.

ILLUSTRATIVE CASES

Spinal concussion. CASE 1. L. J. G., switchman, injured December 22, 1903, account of being thrown from the top of a box car to the ground and striking upon the back and right shoulder. Was unconscious for five to ten minutes. When examined at the hospital he was unable to use the right arm and could not move either leg. Sensation not disturbed and reflexes present, but slightly exaggerated. Slight motion returned in legs in a few days and by January 11, 1904, he was able to return to work.

CASE 2. J. G., switchman, age 48, injured April 17, 1910. On account of defective grab-iron he fell from the side of a box car to the ground, striking upon the back. Symptoms as reported were a motor and sensory paralysis of the arms and all below the level of the first dorsal vertebra. A report of May 12 stated there was a little return of motion in one hand and returning sensation in the other, also a little motion in the legs.

The reflexes were also returning slowly. Bladder and rectum still completely paralyzed. Three X-ray plates were all negative as to fracture. Diagnosis made was hæmorrhage into the cord, cervical region, followed by transverse myelitis and due to severe spinal concussion. The patient died May 29, 1910.

In speaking of isolated injuries to the cord without injury to the spine, Leyden states that from concussion a paralysis may follow at once or soon and may be fatal. The cord shows itself to be lacerated, together with free hæmorrhage or extravasation of blood in the vertebral canal, or it may show no gross or microscopical changes. The real changes, he states, are probably a direct traumatic necrosis of axis cylinders. If a patient lives, recovery may follow quickly, but in all cases where an effusion of blood has occurred a chronic myelitis is to be feared.

Contusion with sprain. CASE 3. H. R. W., brakeman, single, age 26, injured March 11, 1903. While standing in the open door of a baggage car he fell backward out of the car and struck upon a wood rail protecting some signal wires. He was taken home and I saw him within the next hour or two. He had a severe contusion over the region of the left kidney and was suffering from intense pain in the back. The first urine passed following the injury contained a considerable amount of blood and continued to contain blood for several days, after which it became clear. He returned to work in about six weeks, but pain continued off and on for a number of years.

CASE 4. M. C., laborer, age 35, injured August 10, 1909, account of falling from a gravel car to ground and landing upon his back. He was taken to the hospital by ambulance and remained in the hospital under my care up to April 10, 1910, then was kept under observation until May 21, 1910. Examination showed contusions all along the back and spine. Pain was most severe in the muscles on the left side. Hyperæsthesia present from the mid-dorsal region downward. There was a spastic paralysis in both legs, more particularly the left, and a marked increase in all the reflexes. No bowel or bladder disturbance was present. Improvement was very slow, but more in the right than left leg. On January 20 examination of right leg showed muscular spasticity still present, reflexes exaggerated but ankle clonus diminishing, no Babinsky, sensation nearly normal. The left leg showed more muscular spasticity and very much diminished voluntary movements of the leg, due largely, I felt, to fear of increasing pain in the back. All bending movements of the spine were avoided as much as possible. X-ray plates were negative. Not entirely satisfied with the slow recovery, and fearing that a more severe injury had been overlooked, I had him examined by Dr. J. B. Murphy on February 13, and my diagnosis of contusions of the back with some sprain was confirmed. Our line of treatment was unchanged, but the examination was followed by more rapid recovery than at any other time, due to the improved mental condition of the patient. With the added assurance that no serious injury was present he made more effort to get around and soon found that the increased activity did not increase his pain, but rather lessened it. He reported back for work about June 1, 1910.

Sprains from lifting, followed by spinal hæmorrhage. CASE 5. J. J., freight handler, age 30, injured October 2, 1915. While engaged in lifting a heavy casting he experienced a sensation of something giving away, or, as he expressed it, "something snapped," in the back. He was at once disabled and was taken home, where he remained without medical attention until the 13th, when he came to my office for examination. He complained of pain over the third, fourth, and fifth lumbar vertebræ and especially at a point over the spine one inch below the level of the iliac crests. He had had no bladder or rectal disturbance and there was no motor or sensory disturbance in either leg, but the pain in the back had been continuous. His symptoms were all subjective and there were no objective findings upon examination. The diagnosis was muscular sprain and he was instructed in the use of certain muscular exercises and given massage treatments for two weeks. He reported November 5 that he was much improved and intended resuming work in a few days.

CASE 6. E. W. H., station agent, age 34, married, injured August 24, 1907. Previous history negative. While in the act of lifting a heavy propellor blade he experienced a sensation of something giving away, and of an immediate weakness in the lumbar region and through the hips. He rested for about half an hour, then resumed work, but did not attempt to do any heavy lifting. He experienced no unusual symptoms that night and was at his office the following day. He had no real pain, but did not feel right. He went to the White City park that evening and spent several hours walking about. He slept well that night and had no uncomfortable symptoms. The following day, the 26th, he was at the office and did some work at the warehouse as on the 24th. He was restless that night and did not sleep much, but was not up. The next day, the 27th, he did not feel right but spent all day at the office. That night he could not sleep or rest in bed on account of pain across the lumbar region of the back and a distressed feeling through the hips, and he walked the floor until about 6 a.m. the following morning. About this time the pain became less and, feeling very tired and weak, he went to bed and slept for about two hours. When he awoke he was unable to get up on account of a complete motor paralysis of both legs. Called in a day or two later, I found upon examination a motor paralysis of both

legs, but no marked disturbance of sensation. The patellar and plantar reflexes were absent. There were no ankle clonus and no Babinski reflex. There was no involvement of the bladder or rectum except for slightly diminished sensation, which returned to normal within the next week. Examination February 25, 1908, showed no improvement. The muscles of the legs were greatly atrophied, but had retained some size through the use of massage and electricity. He stated at this time that he felt a little more strength in the muscles on the anterior surface of the right thigh, but this was not apparent. There has been no material improvement since then. He still has a complete paralysis of both legs, but retains control of the bladder and bowels. Sensation is practically normal. I have never been able to satisfy myself as to the exact lesion in this case, but believe it to be located in the cauda. The most interesting features of the case are the equal involvement of both legs below the level of Poupart's ligament without loss of control of bladder and rectum, and the presence of practically normal sensation.

CASE 7. W. C. S., machinist's helper, age 16, injured January 25, 1910. In letting go of a heavy piece of iron which he was lifting he felt a sudden pain in the chest and back. He was almost immediately disabled and when examined at the hospital was found to have a motor and sensory paralysis of both legs and of the bladder and rectum. He complained of severe pain in the spine. Two days later sensation and some motion returned to the right leg, but the left was unchanged. February 7 it was reported that sensation was normal in the right leg, but that there was less motion than a week before. Anæsthesia on the left side extended nearly to the lower border of the costal arch. I examined the case February 10 and found both legs paralyzed, but sensation present in the right. All the reflexes were absent except the plantar reflex in the right leg. Bowel movements were involuntary and there was incontinence of urine. The abdomen was distended and rigid. From the costal margin to the hips on both sides sensation varied, being present at times and absent a moment later. There was more loss of sensation in the left side. He stated that he could move the right leg some the first day after injury, but not since then. No muscular atrophy was present at this time, but there were a number of well developed decubitus areas. On March 1 sensation was present over the whole right side and to some extent in the left foot. There was a little return of motion in the left foot. The symptoms varied slightly from then on, but he gradually lost weight and strength and finally died July 16, 1910. The diagnosis in this case was an extradural hæmorrhage due to sprain from lifting.

Sprains with nervous or hysterical symptoms. CASE 8. E. W., switchman, age 31, injured November 15, 1905. Admitted to hospital on account of injury claimed to have been received on railroad. Complained of severe pain in the back and in the head and talked at random. No paralysis was noted. On November 22 he sat up in chair for first time and was up each day until the 26th, when he complained of feeling bad again and remained in bed. Later in the day he got up and left hospital. I next saw him on January 4, 1908. At this time he claimed to have been struck in the back by a street car and knocked down. He was brought to the hospital, where upon examination we found a complete left-sided paralysis and some diplopia. He appeared delirious at times. Motion returned in the left leg the next day and the remaining symptoms cleared so that he was up on the fourth day and was discharged from the hospital January 11. That same night I was called to see him in another hospital on account of an injury sustained through being struck by an engine. Examination this time revealed a complete motor and sensory paralysis below the level of the fourth lumbar vertebra. There was rectal anæsthesia and retention of urine for several days. No loss of reflexes. Complained of diplopia for first 24 hours, also complained at times of an unnatural feeling in left hand. Expressing a desire to go home, we put him on a stretcher and on a train bound for Ohio, without waiting for his recovery. I next heard of him on account of an injury received November 7, 1908. He was in a hospital in Ohio, suffering from a paralysis of both legs due to railroad accident. The attending surgeon learned of two more alleged injuries between January and the one of November 7, and while making an examination of one of the paralyzed feet stuck a needle well into the foot. This met with a shout of pain, and upon being ordered to get up and leave the hospital the man promptly did so. A man answering the same description and of the same name was picked up and taken to a hospital in Canton, Ohio, on December 12, 1908, where it was reported he was completely paralyzed from the hips down. I did not hear the outcome of this attack. This man undoubtedly was suffering from a hysteroneurosis, the paralytic attacks being easily precipitated by a slight injury to the back, and this knowledge was being used by him to defraud corporations.

CASE 9. J. McE., hostler, injured October 3, 1908. He was reported to me as having been struck in the back by a baggage truck and knocked down. Examination showed a complete paralysis from the hips down, with no local evidences of any injury. The diagnosis was hysterical paraplegia. He recovered sufficiently to leave the hospital two days later. The history of this case developed that he had been treated for the same condition on numerous other occasions following falls from street cars, railroad trains, and once from shaking the grates on an engine.

CASE 10. Mrs. N. G., housewife, injured February 17, 1910. Claimed that a sudden stop of train threw her back against seat and injured her back. She had severe pain in the back and down the right thigh. She was unable to pass urine. X-ray

negative. She was examined by a neurologist, who found nystagmus, exaggerated reflexes, ankle clonus, and loss of corneal and pharangeal reflexes. Diagnosis: traumatic neurosis of hysteroid type.

CASE 11. A. E. I., merchant, age 35, injured February 22, 1913. Claimed to have been lying in berth when sudden stop of train threw him up against head of berth, causing contusion of head and sprain of muscles of neck. A neurologist in Cleveland who examined him the day of the injury found no motor or sensory disturbances, no inco-ordination, normal reflexes, and no objective signs of injury. The man stated he felt all right until some hours after the injury. Subsequently he was examined by seven or eight prominent surgeons and neurologists on account of pain in the neck and the usual nervous symptoms found in a traumatic neurosis. In all cases the diagnosis was the same. This man was still complaining for more than a year following injury.

Malingerers. CASE 12. O. W., helper, injured September 20, 1909, by falling into a pit. Was picked up unconscious. He sustained a severe contusion of the spine over the upper dorsal region. Confined to hospital up to October 22. A report under date of November 12 stated that the man walked well with use of a cane for two weeks after he left the hospital, then began using crutches and complained very much of pain in the back. The case was settled shortly afterward and four days later the man discarded his crutches and desired to resume work.

CASE 13. T. E. L., conductor, age 43, injured April, 2, 1913, through a fall from the top of a car to the ground. He complained of pain in lumbar region, but no mark of injury was found upon examination. He consulted several different physicians about his back, but on May 21 was examined by a neurologist, who stated that the man was either a poorly instructed malingerer or he might have a traumatic neurosis with marked exaggeration of signs and symptoms. This case was settled, and immediately after the man went on a "drunk" lasting three days.

ABDOMINAL PREGNANCY[1]

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ABDOMINAL pregnancy which may be defined as the development and growth of the fœtus in the abdominal cavity may be either primary or secondary. The fact that primary abdominal pregnancy may occur is denied by some authorities although Parvin (1) gives Kleinwachter's explanations of its occurrence as follows:

1. The ovisac may rupture so far from the ampulla that the current caused by the movement of the cilia cannot carry the ovule into the tube.

2. A temporary abnormal position or movement of the abdominal organs may obstruct the passage of the ovum.

3. The end of the tube may be completely closed in consequence of former inflammation, and the ovule be impregnated by semen coming through the other tube.

4. The tubal orifice may be so narrow that while permitting spermatozoa to pass, the ovule enlarged by impregnation cannot pass.

5. The tube may have lost its cilia from disease, and the current fail so that the ovule is not carried to the tube.

6. Old exudations or pseudomembranes may either obstruct the orifice of the tube, or be in the way of the ovule reaching the orifice.

7. Abdominal pregnancy may occur when both tubes are normal. The ovule impregnated at one tube may pass out into the abdominal cavity, and then cross to the other tube, but the latter will not admit it because meantime the ovum has become too large.

This last is certainly a most ingenious explanation. The condition may also arise from an ovum escaping through the scar following a cæsarean operation or through the fistula in the cicatrix of a cervix remaining after the performance of subtotal hysterectomy. With all these possible explanations it seems difficult to exclude the occurrence of a primary abdominal pregnancy. There are very few definite cases reported. Among them those of Béhier (2) and Calloway (3) bear close investigation. Many experimenters on animals prove from their experiences that primary abdominal pregnancy is to be considered a very possible occurrence; Blair Bell (4) concludes that because it is common in a rabbit

[1]Read before the Obstetrical Section, Royal Academy of Medicine in Ireland, February 11, 1916.

it cannot be counted unlikely in a woman. Bruce White (5) and many others use these experimental means to prove the same theory. The apparent fallacy which may arise from the physiologist attempting to prove a gynecological problem is shown when one reads that whereas Bruce White, Pembry and Bellingham Smith (6), Kamann (7), and many other physiologists demonstrate that abdominal pregnancy is common in animals and that the condition usually arises from ruptured uterus, yet Bland-Sutton (8) who is evidently a combination of a physiologist and gynecologist shows that abdominal pregnancy is rare in the human being while it is the common form of extra-uterine gestation in mammals with long two-horned uteri. He (Bland-Sutton) considers that cases in the cat-rabbit tribe are not primary but they are like the celebrated case of Leopold (9) which arose from a rent in the posterior uterine wall. While disclaiming any leaning to antivivisection it is plain that vivisection is not a success in proving data about abdominal pregnancy. Secondary abdominal pregnancy is more feasible than primary and may arise from such causes as:

1. Rupture of the tube with attachment of the placenta to different sites in the abdomen.
2. Rupture of uterus with escape of ovum.
3. Extrusion through the fimbriated end of the tube with escape of the ovum, etc.

The diagnosis of abdominal pregnancy is a matter of extraordinary difficulty. In my case it was well nigh impossible to diagnose definitely. This difficulty is dwelt on particularly by various writers. Allen (10) tapped a case thinking it was ovarian cyst. Hutchinson (11) did the same. These women died. Barnes (12) was most unfortunate in his experience for he says that in almost all the cases in which this form of gestation was suspected turned out to be ovarian cysts. Currier (13) in a paper on "Erroneous Diagnosis in a Case of Abdominal Pregnancy" agrees in this difficulty. In Lusk's (14) historic paper there are two recoveries in both of which the abdomen was opened with the idea of removing an ovarian cyst. There are *many* cases reported of the patient being allowed to progress beyond full term with the idea that intra-uterine pregnancy was present. Carson (15) performed laparotomy for abdominal pregnancy when a large child with hydramnios was discovered. The conglomeration of opinion is that diagnosis of abdominal pregnancy may be established by the following:

1. The extreme sensitiveness.
2. There are no intermittent contractions (16).
3. The irregular outline.
4. The child is directly under the skin.
5. The heart sounds are directly under the ear.
6. The fact that retroversion is a common accompaniment (17 and 18).

The history of a case which occurred in my practice follows:

Mrs. W. was admitted to Mercers Hospital on December 31, 1915. She was 33, had been married ten years and had never become pregnant until the present instance. Four months previous to admission she complained of pain in the abdomen which gradually increased until it became nearly unbearable. She suffered from dysuria and frequency of micturition, also vomiting. When walking she had much pain in the lower abdomen. In September, 1915, she consulted Dr. Ryan of Loughrea, who told her he thought she was pregnant and assured her of it in January last when he sent her to hospital. The patient was a very frail woman who gave no history of previous illness or operation. Menstruation before marriage was regular. Since marriage irregularity was constant; it usually lasted 24 hours and was not accompanied by pain. There was sometimes an interval of six to eight weeks between each period. Her last menstruation was early in July 1915. She always suffered from a white intermenstrual discharge.

On examining the abdomen there was found a mobile tumor dull on percussion, fairly regular in outline, and extending to the umbilicus. On examination bimanually the cervix was found to be retroverted. The tumor in the abdomen seemed to be connected with the cervix and yet there seemed to be a soft cystic swelling in the posterior and lateral fornices also connected with the abdominal tumor and cervix. The tumor in the posterior fornix was replaceable but returned immediately. Fœtal parts and movements were distinguishable both abdominally and by the vagina. The differential diagnosis lay between intrauterine pregnancy with ovarian cyst and retroverted pregnant uterus with ovarian cyst. In demonstrating the case to a class I mentioned the possibility of abdominal pregnancy but dismissed the idea. Although the patient was on operating table, I decided to postpone action for a week. Having examined her twice without and once with

anæsthetic, I asked Dr. Glenn, consulting gynecologist to the hospital, to see the case with me. He agreed it was impossible to diagnose definitely, that there was some marked abnormality and that the best policy was to open the abdomen.

To touch on these diagnostic points of the case in comparison with those points which I was able to gather from my study of the subject.

1. Sensitiveness was present though not extreme.
2. Intermittent contractions were not noticeable. This does not seem to be a very distinguishable sign for while these contractions are valuable diagnostic points when present, their absence does not contra-indicate pregnancy.
3. There was marked irregularity of outline.
4. The child was not directly under the skin.
5. Heart-sounds were not directly under ear.
6. Retroversion was present.

On January 8, I opened the abdomen by a mesial incision from the symphysis to two inches above the umbilicus. A tumor hæmorrhagic in appearance stretching a little beyond the umbilicus was seen. In separating the adhesions of the tumor which were numerous and were chiefly to the intestines, omentum, posterior pelvic wall and uterus, in the left iliac region the finger entered the sac and a fresh fœtal foot was extruded. There was some old blood on the right side and there was much fresh hæmorrhage from the separated parts of the sac. It was necessary to remove and tie-off omentum in several places while the rectum for two or three inches required oversewing where the placenta was removed. There were several pieces of tissue removed during the operation which consisted possibly of some kind of sac. While the operation was in progress the patient was given saline submammary; pituitary extract 1 ccm.; strychnine sulphate, gr. 1/30 etc. When the fœtus and placenta had been removed it was apparent that the right tube had been taken away in the mass. The uterus, left tube and both ovaries were left *in situ*. The diagnostic difficulty was here made apparent for the uterus lying retroverted without retroflexion was practically imbedded in the tumor which filled the pelvis. It was impossible to investigate further for the patient was much blanched, was pulseless at one period of the operation and it was necessary to close the abdomen as quickly as possible, and to get the woman to bed where continuous rectal saline and other usual restorative measures were carried out. On the sixth day cystitis developed which persisted for seven days. On the fourteenth day she passed per rectum a wash leatherlike piece of material which Dr. Wigham reported to be a cast of the rectum. This phenomenon was a marked proof of the irritation to which the bowel had been subjected. The long abdominal wound healed by first intention and she was discharged from the hospital in good health on the twenty-sixth day.

The history of the treatment of abdominal pregnancy is interesting. Firstly, there were the days when the condition was always found post-mortem. Next when treatment was postponed until after the death of the child (19), or when the child was removed and the placenta left (20, 21, 22). In those days gynecologists were vying with each other to find the best infanticide. Barnes (23) injected into the sac atropine and strychnine. Friedrich (24) morphine, while Thomas, (25) and many others were using the electric current. Barnes inoculated the mother with syphilis to kill the child. Generally speaking, the results of these measures were disappointing.

The pathological report does not throw much light on the subject. The specimen consisted of a 5 to 6 months fresh fœtus and placenta. On the maternal surface of the placenta is seen an area which on microscopical examination proved to be blood-clot and which probably is the place where it was implanted on the rectum. Sections from various sites showed nothing abnormal. A search was made for tubal tissue but none could be demonstrated. Much omentum was removed and a microscopical examination of portions of this failed to show the presence of decidual cells. Outerbridge (26) has proved that decidua-like cells are found in the omentum in cases of intrauterine pregnancy: This has been noted by Schmorl (27), Kinishita (28) and Shaviodskiadis (29). They have also been found on the peritoneum covering the posterior surface of the uterus, the anterior wall of the rectum, in the appendix (30) in a parovarian cyst (31), and in the vagina (32). It is strange that in my case there was no decidual reaction in the omentum removed.

The most probable explanation of the case is as follows: That there was a very slight rupture of the tube at 2 to 3 months; that the ovum remained attached partially to the tube and that as it grew the placenta attached itself to rectum, omentum, and posterior pelvic wall, etc.; that this caused irritation which predisposed to a connective-tissue proliferation thus surrounding it with a vascular sac. The patient evidently sought Dr. Ryan's opinion shortly before the time I first saw her on account of the pain caused by the enveloping sac which was much stretched; this latter fact was clearly demonstrated during the

operation. If no operation had been performed, what would have been the result? She might have progressed to full term. She might have shown symptoms of distress earlier. Cases are on record where the dead fœtus has been carried for many years in the abdomen. Heiskell (33) reports a case of 40 years' duration. In the present case it seems most probable that hæmorrhage or other dangerous symptoms would have appeared soon.

The following are important points in connection with abdominal pregnancy:

1. The fact that the cause of abdominal pregnancy has not been definitely established.

2. The extreme difficulty in definite diagnosis.

3. From a review of the literature and of my own case (though not wishing to argue from one experience) the rational treatment seems to be to remove fœtus and placenta and to stop the hæmorrhage. This hæmorrhage can be stopped; therefore it is bad policy to leave the placenta *in situ*.

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RHABDOMYOMA OF THE PROSTATE

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THE number of reported cases of sarcomata of the prostate gland which have been microscopically examined and well authenticated is very few, and the number of rhabdomyomata fewer.

With reference to rhabdomyomata, Kaufmann records three cases only. It is possible, however, that some of the spindle-cell sarcomata of the prostate may be more properly classified under rhabdomyosarcomata; but this can never be proved except by re-examination of the pathological material of the old reported cases, a condition now impossible to meet. It is certain, however, that rhabdomyomata are most frequently found in and about the urogenital system; as for example in Wolfenberger's[1] collection, while there are no cases reported as from the prostate; yet out of 63 cases of rhabdomyoma, 38 involved the urogenital system.

Kaufmann: Case 1. A child nine months of age had symptoms of bladder trouble, with partial retention and pain, for six weeks. He died in the hospital, without operation. At post-mortem, an oval tumor was found occupying the region of the prostate. It measured 5x5x4 cm. The surface was smooth and covered by a fibrous tissue capsule. Neither the ureter nor the seminal vesicles were involved in the growth, but there was a right-sided hydronephrosis and a left-sided pyelonephritis. The walls of the bladder were thick and trabeculated.

[1] Ziegler's Beitr. z. path. Anat. u. z. Path., Jena, 1894, xv.

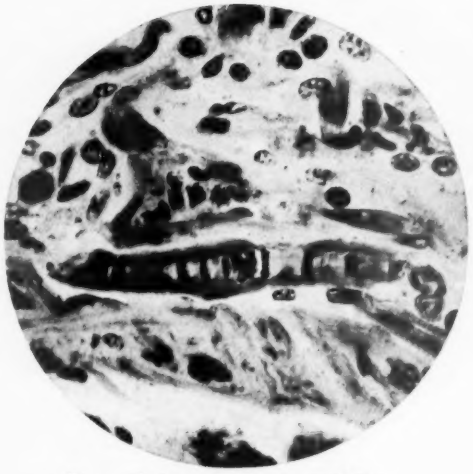

Fig. 1. Embryonic type of muscle-fibers.

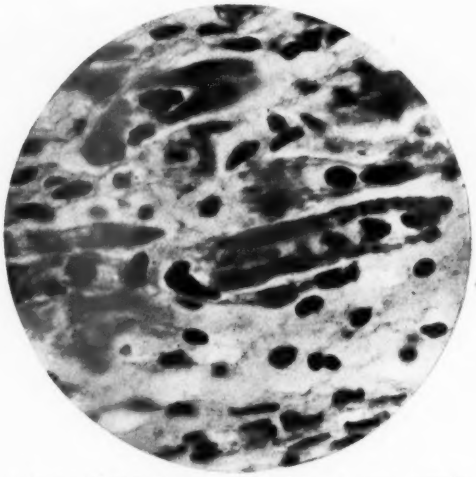

Fig. 2. Muscle-fibers from fœtus of two months, showing close resemblance of the fœtal fibers to the irregular fibers in Fig. 1.

The tumor was almost completely extravesical, the lumen of the rectum being nearly closed by the tumor. There were no metastases, either in other organs or in the lymph-nodes of the neighborhood. On section, the tumor was found to be firm, hard, and divided into irregular areas by bands of connective tissue. On microscopical examination the tumor gave the impression, under low powers at least, of a spindle-cell sarcoma; but more careful examination of the individual cell-forms under higher powers showed that in many cases the spindle-shaped cells which resembled those of a sarcoma were in reality more or less rudimentary muscle-fibers. In some of these fibers cross striation could be easily made out. The muscle-fibers in various parts of the tumor assumed bizarre shapes, with clubbed ends and numerous nuclei, some of the cells being almost spherical, others drawn out into long tapering strands of cell-substance. Some of the longer fibers had a row of small pyknotic nuclei arranged in a clear central space, the portion of the cell and the long terminal sprouts showing striations. It was, however, in many cases difficult to differentiate long, thin muscle-fibers from connective-tissue of similar size; hence the difficulty in differentiating this tumor from a sarcoma. Kaufman thinks it probable that this tumor should be classified with the rhabdomyosarcomata because of the large number of cells which could not be definitely determined as muscle-fibers, though the tumor did not involve the surrounding structures and there were no metastases.

Fig. 3. Longitudinal section of striated fibers more highly developed than those in Fig. 1.

Case 2. The patient, a four-year-old boy with a history of urinary retention, was found to have a very large tumor of the bladder which projected into the vesical lumen and also into the rectum. He died of suppurative cystitis with bilateral pyelonephritis. At autopsy, the growth was found to be the size of two fists. It involved the prostatic region as well as the seminal vesicles and the vas deferens. Although of this large size, it was still movable in the pelvis. The chief portion of the tumor spread out widely over the anterior portion of the bladder-wall, projecting into the lumen of this organ in irregular lobular form. The ureters were also involved, especially the right. On cross section the tumor was soft, smooth, in some places jelly-like, and resembled clinically a sarcoma. Microscopical examination showed in some areas a soft myxomatous tissue, in

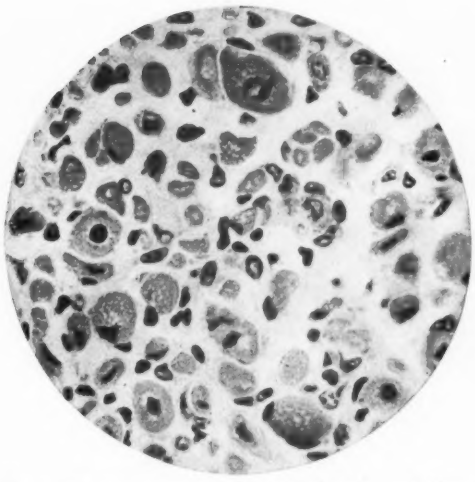

Fig. 4. Transverse section of well-developed muscle-fibers.

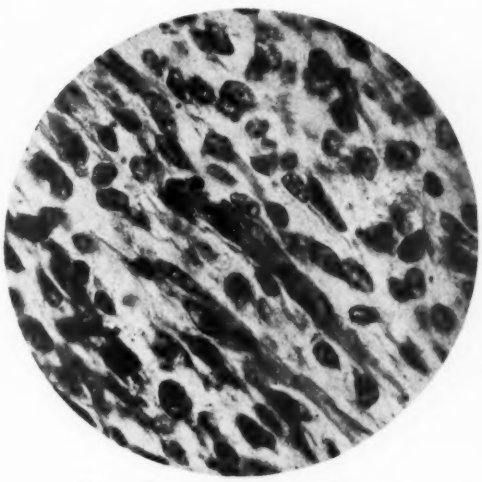

Fig. 5. Sarcomatous portion of tumor.

other cases firmer structures, containing numerous spindle-cells and a moderate number of fields in which poorly developed muscle-fiber with cross striation could be demonstrated. Because of the large number of spindle-cells, this tumor must be called a rhabdomyosarcoma, although no metastases were found in any of the different organs or in the lymph-nodes.

The third patient was a 26-year-old man suffering from pain, fever and anæmia, but without urinary symptoms. The tumor was evidently malignant, as it involved not only the bladder and the prostatic region, but also the wall of the pelvis, and metastases were found in the liver, lungs, pleuræ, the mucous membrane of the stomach, the thyroid gland, the external and internal surfaces of the dura. There were numerous metastases scattered throughout the bones. The tumors in the lungs and dura were calcified. The microscopical examination of the tumor showed a myxomatous, very cellular mass in which could be found bundles of embryonal muscle-fibers showing all the characteristics of striated muscle. The tumor was, however, much more cellular than those previously described. In the metastases, especially one in the dura mater, the same large irregular cells could be found which were characteristic of muscle-cells in the primary growth. The presence of the numerous metastases is explained by involvement of walls of the veins, by the primary tumor and the presence in the lumen of tumor-tissue. The origin of the striated muscle-fiber in these congenital or acquired tumors of the connective-tissue group must be laid to an embryonal displacement of striated muscle, possibly arising from the sphincter muscle of the neck of the bladder. A metaplasia of smooth muscle-fiber into striated muscle-fiber is extremely improbable.

The case which I desire to add to these reported presented the following history:

The patient, a male 40 years of age, was examined in September, 1915. He was tall, athletic, sparely nourished, but in excellent general condition. For a period of three months he had suffered from a painless hæmaturia. The blood would appear with the last portion of the urine voided. With certain acts of urination blood was absent, but at some time every day it would be present. Increased urinary frequency existed. His health had been excellent and he had had no serious illness at any previous time in his life. Physical examination of the heart, lungs, and abdomen was negative.

Local examination of the prostate by rectal palpation, revealed a smooth, symmetrically enlarged gland of almost flinty hardness. It felt about as large as a hen's egg and no periprostatic infiltration could be appreciated. Cystoscopic examination showed marked trabeculation of the bladder-wall. The prostatic urethra was injected and bled from instrumental trauma. There was no intravesical prostatic projection and no residual urine. The urine was negative except for the presence of blood.

The diagnosis was made of early prostatic neoplasm, and operation advised. This the patient accepted.

On September 11, 1915, under general anæsthesia, a radical extirpation of prostate, bladder neck, and seminal vesicles was performed.

The prostate was exposed through transverse perineal incision. After division of the membranous urethra close to the apex of the prostate, the prostate and neck of the bladder were pulled downward and amputation of the vesical neck made posterior to the prostate. The seminal vesicles were removed

en masse with the prostate, ligation of their blood supply and vasa having been first accomplished.

An anastomosis was then made between the urethra and the neck of the bladder by approximation over an indwelling urethral catheter. Closure of the wound, with gauze drains down to the urethrovesical anastomosis, completed the operation.

The specimen removed was about the size of an egg. It had been removed easily and nowhere seemed adherent to surrounding structures. The growth was localized within the lateral lobes and did not seem to involve the urethral portion of the gland or to have extended outside of the capsule.

The patient's convalescence from operation was most satisfactory. The indwelling catheter drained the bladder for four days, when it was removed.

The perineal wound healed well, the gauze drains were removed on the fifth day. After removal of the indwelling catheter, urine was voided through the perineal wound as well as urethra, but by the thirteenth day the perineal wound was tight and the patient had no urinary incontinence. He left the hospital on the twenty-second day after operation.

The material removed at operation was submitted for study to the Pathological Department of the Post-Graduate Hospital, to Dr. F. E. Sondern, and to Dr. F. C. Wood. The diagnosis received from all was rhabdomyosarcoma.

The examination of the gross tissues showed two irregular fragments of ragged outline, measuring about 7.5x5.5x2.5 cm. A portion of this mass was smoothly encapsulated, and to this encapsulated part were attached remnants of the seminal vesicles. The hardened tumor as reconstructed was a flattened oval mass, smooth, white, and firm on section. In some areas dilated prostatic gland tubules filled with yellowish material could be made out. A few dark-colored areas showed hæmorrhage into the tissues.

The microscopical examination showed three different structures:

1. A very glandular, somewhat inflamed prostatic tissue; the amyloid bodies were scanty and some of the alveoli contained pus-cells.

2. Dense fibrous tissue and glandular structures commingled with fibrous tissue, smooth muscle-fibers, and large numbers of striated muscle-fibers, some very large, long, and branching, others irregular in shape, with numerous nuclei; some club-shape fibers also were present. The fibers showed all the peculiar morphological appearances of the striated muscle-fibers seen in rhabdomyomata of the testicle and in the striated muscle of the fœtus (Figs. 1, 2, and 3). Cross sections of the fibers showed the usual circular or oval outline, with a large nucleus in the space in the middle of the fiber. Transverse striations of the muscle were so well marked in many places that there could be no question as to the nature of the fibers (Fig. 4). In some areas of this portion of the tumor there was, in addition to the glands and the striated muscle-fibers, a small amount of spindle-cell tissue, looking like newly formed or embryonic cell-tissue, but not sufficiently characteristic to permit of the diagnosis of sarcoma.

3. In other portions of the tumor there was a third variety of tissue, a pure spindle-cell sarcoma with very little collagenous material between the cells, the nuclei of which were large, rich in chromatin, and showed mitoses (Fig. 5).

To sum up: We have here a glandular hyperplasia of the prostate with the development of a rhabdomyosarcoma therein.

The subsequent course of events follows:

He returned to his home and for a time convalesced well. X-ray treatments were instituted after operation, as a possible aid against recurrence. Six weeks after operation no induration could be appreciated by rectal examination. Two months after operation recurrence of the disease appeared in the perineal scar, and rapid extension into the rectum became evident. Since then the disease has rapidly extended and the inevitable is approaching.

EVENTRATION OF THE DIAPHRAGM AND DEXTROCARDIA[1]

With a Case Report

By H. G. WOOD, M.D., Galesburg, Illinois

A CASE of diaphragmatic eventration and associated dextrocardia has recently come to my notice. This condition is, I feel, of sufficient rarity to make its publication desirable.

Apparently, eventration was first described and named by J. L. Petit, when he reported a case in 1790. This term has been in common use ever since. In 1912, in his paper on "Diaphragmatic Hernia," (1) Dr. H. Z. Giffin pointed out the fact that the term eventration would apply equally well, or even better, to a true diaphragmatic hernia, in the commonly accepted sense. By reason of its common acceptance, however, the term eventration has been continued in this article. In sup-

[1] Read before the Henry County Medical Society, Kewanee, Illinois, November 17, 1915.

Fig. 1. Skiagram, anterior view of patient prone. *A*, Heart shadow in right thoracic cavity; *B*, left half of diaphragm rising to the lower margin of the third rib.

Fig. 2. Skiagram, posterior view, patient prone with buttocks elevated, and shoulders down. *A*, Heart shadow in right thoracic cavity; *B*, left half of diaphragm in contact with cardiac portion of stomach, *C*, shown well filled with barium by gravity and the gas bubble, *D*, in the pyloric portion.

port of Petit's nomenclature, it may be stated that he believed the case he reported to be one form of true diaphragmatic hernia.

In the recent English literature on the subject, the most extensive article is one by Sailer and Rhein (2), and to this paper I am indebted for most of the cases mentioned. Since 1905, the *Index Medicus* lists only a short brief of an article by Dr. Hermann Fisher (3) under the title "Relaxation of the Diaphragm." He reported a case.

The history of the case I report is as follows:

Patient is a female, 18 years of age. Family history, unimportant. Personal history. At age of seven years the patient fell from second story, and struck in sitting posture. No serious results were noted at the time. Three years ago she had typhoid fever. Menstruation was normal. She had had several operations for nasal obstruction.

Chief complaints. (1) Dyspepsia; (2) epigastric soreness; (3) abdominal bloating and belching; (4) palpitation; (5) dyspnœa.

History. The patient left school in 1914. She has worked as a stenographer a little over a year. She is not certain as to the duration of symptoms, but for at least ten years has been bothered by an "upward pressure in chest," especially if she ran, or walked up hill. She felt as though her "heart was pressed upon," and asked, after the examination, if her heart was not on the right side. She said she always thought it was. She cannot remember whether these symptoms were present before injury, or not. She has never been very strong, but was always able to indulge in the usual recreations of her friends, and the symptoms at present complained of have appeared, or have been aggravated within the last year.

She has been very nervous for a year, and during this period of time has had much soreness in the epigastrium, with abdominal bloating, also gas belching which relieves these symptoms. She craves sour food and acids, which cause no distress; heavy and greasy foods aggravate the symptoms (2 to 3 hours postcibal) and feels better if on very light diet, but no food ease noted. Occasionally she feels nauseated, but does not vomit. The above symptoms were not constant until the past month. Also constant dyspnœa for several weeks, and palpitation on exertion; previously, only palpitation and dyspnœa by spells, when the gastric symptoms were distressing. These are aggravated by a

hearty meal and also when she lies down. The patient eats very rapidly and is always hungry, but does not lunch. Her weight is about normal. There is soreness across lower abdomen when she menstruates. The bowels are regular. She has occasional frequency of urination (nocturnal 2 or 3 times) but never pain. *Physical findings.* Height, 5 feet, 2 inches.; weight, 99.5 pounds (normal). Nutrition fair, systolic blood-pressure, 118; dystolic blood-pressure, 74; pulse, 86; temperature, 98.2°; hæmoglobin, 77 per cent. Urinary findings negative. *Inspection.* Expansion equal; apical impulse perceptible at the fourth interspace at right margin of sternum. Slight lateral scoliosis. *Percussion.* Cardiac dullness. Left margin of sternum to point 2.5 in. to right of it. Left supraclavicular and infraclavicular region, anteriorly, slightly hyperresonant note. Tympany over precordial area to level of third interspace. *Ascultation.* Breath sounds over left upper lobe higher pitched than on right. Gurgling heard over tympanitic area with absence of breath sounds. Heart sounds normal. Heard most clearly to right of sternum. *Radiographic examination* showed eventration of diaphragm and dextrocardia (see radiographs.)

In all, about 500 cases of hernia and eventration have been reported, but Fischer was able to find only twenty-three of eventration, and Sailer and Rhein, in 1905, could collect only twelve definite cases, besides their own, though there were several discarded because of insufficient data.

We may safely assume that the condition is very much less common than diaphragmatic hernia, with which it is most apt to be confused. Fischer defined eventration as "a thinning out and fatty degeneration of the muscular fibers of the diaphragm and bulging upward of the same to the level of the second or third rib." Sailer and Rhein define it as "an abnormally high position of the left half of the diaphragm with dislocation upward of the andominal viscera, especially of the stomach, with hypoplasia of the left lung and dislocation of the heart to the right."

The etiology is uncertain:

1. Some writers consider it as a true hernia.
2. Others believe that it is secondary to hypoplasia of the lung.
3. It is considered also the result of dextrocardia.
4. Some think it is due to a primary congenital defect of the diaphragm.
5. Again, it is regarded as a result of acquired lesions.

Of the 13 cases reported in 1905, 1 was found in a fœtus, one in a newborn baby, and 11 in patients ranging in age from 19 to 75 years of age. On these cases there were twelve post-mortems, and one patient was still living. Two of the cases died of peritonitis, one of pneumonia, 1 of typhoid and 1 of a carcinoma of the tongue. In at least 6, the condition was found accidentally at post-mortem. Two cases were reported as dextro-cardia. Apparently, an abnormal condition of the diaphragm was suspected in only four or five.

The clinical symptoms were very irregular. One patient complained of asthmatic attacks, relieved by eating; one of vomiting and gastric disturbance; and one had hæmatemesis, and from the symptoms an incarcerated diaphragmatic hernia was suspected, and an operation performed, at which time an eventration was found.

I have also seen a case of intestinal fistula of the left thorax, in which the patient had been operated upon, under the supposition that an empyema was being dealt with, and instead of which there was a true diaphragmatic hernia.

One case is reported in which the symptoms appeared after pneumonia. In one case, an adult male, after a severe shock there was a sense of "something giving way" followed by cough, dyspnœa and pain in left chest. At post-mortem, an eventration was found.

Fischer also mentions a case in which the condition seemed to develop following pneumonia, and after a time cleared up. Here, a diagnosis of paralysis of the *left phrenic nerve was made.* Sailer and Rhein believe it is the result of a hypoplasia of the left lung, together with a hypoplasia of the left half of the diaphragm. The majority of cases are undoubtedly congenital, and this hypothesis is true in many cases.

In some, however, that appear to be congenital in origin, there is no hypoplasia of the left lung. In others, again, there appears to be a definite association of eventration with an acute infection, and in some cases there is found a diffuse fatty infiltration, or a fatty degeneration of the muscular fibers of the diaphragm. In one of the cases mentioned, and in the one I report, there seems

to be a definite relation to traumatism. Undoubtedly, the vast majority of cases are due to congenital defects of the diaphragm, or left lung, or of both. Other conditions must also be considered, as it appears that "acute infections, traumatism, and injury to the left phrenic nerve," are occasionally etiological factors.

The case here reported is of especial interest as the clinical findings and the history of previous trauma would lead one to suspect that he was dealing with a diaphragmatic hernia. In fact, without the radiographic findings, I do not believe that a diagnosis of eventration could be made. The chief difficulty is always in distinguishing between these two conditions. It is also stated that pneumothorax, cavitation of left lower lobe and subdiaphragmatic pyoneumothorax must be differentiated. I do not feel that the latter conditions offer much diagnostic difficulty.

A pneumothorax should present characteristic physical findings, and there would be bulging of the intercostal spaces, and immobility of the left thorax; while in eventration or hernia the respiratory movements appear normal.

It is not conceivable that cavitation of sufficient extent to be mistaken for eventration could exist without a previous history and sufficient clinical evidence of pulmonary disease to make the diagnosis clear. Both of the above conditions could at once be positively diagnosed also by a radioscopic examination. Subdiaphragmatic pyopneumothorax is also stated to be a condition to be distinguished. I have seen one case, as well as several of subdiaphragmatic abscess, and in none of them was the possibility of eventration or hernia considered. These generally result fron a rupture of diseased gall-bladder, or the perforation of a gastric or duodenal ulcer. They also are occasionally the result of infection following abdominal operation. The history of the case, together with the definite evidences of sepsis present, should be sufficient to exclude eventration or hernia.

The one condition that offers serious difficulty in differentiating from eventration is diaphragmatic hernia. These conditions may present identical clinical manifestations, and can be differentiated only by a careful radioscopic or fluoroscopic examination. In most instances a radiogram, or a fluoroscopic examination, would satisfactorily differentiate the two; though occasionally a combination of the two methods would be necessary. In the present instance, the first plate is sufficient to clear the diagnosis. Occasionally, however, the air bubble in the upper part of the stomach leads to a false line appearing below it, which has been mistaken for the diaphragm; and because of this, a mistaken diagnosis of hernia is made. This mistake can be avoided by filling the stomach with barium solution, and taking a plate with the patient's hips sufficiently elevated to fill the cardiac portion and force the air bubble to the pyloric end. The same result can be attained by fluoroscopic examination after giving barium, and palpating the abdomen so as to thoroughly fill the cardiac portion of the stomach.

Another important diagnostic point is the fact that in hernia there is fixation of the diaphragm, and in eventration the respiratory excursion appears normal. This is best determined by the fluoroscope. In the present case there is normal mobility of the diaphragm. A lack of movement would also be found in eventration resulting from a phrenic paralysis, and the association of an eventration with a fixed diaphragm should suggest the latter condition.

The extreme importance of differentiating between eventration and diaphragmatic hernia is due to the fact that hernia is a surgical condition, and operation is followed by good results; while eventration is not so considered.

In this connection, a point of much theoretical interest is: What would be the result of a plication of the diaphragm? Such an operation should be attended by no greater risk than the operation for hernia. The result would be dependent upon the ability of the diaphragm to withstand the increased abdominal pressure. It is possible, of course, that this would lead to a further stretching of its attachments and a recurrence of the condition. This point could possibly be cleared up by an experimental plication of the

diaphragm in dogs, though it is questionable whether an experimental eventration could be produced by section of the phrenic nerve. Unless such an artificial eventration could be produced before plication, the experimental proof would not be conclusive.

Many cases of eventration suffer little discomfort, and, of course, in such the risk of operation is not warranted. If, however, the condition is attended with sufficient symptoms to interfere seriously with the patient's physical well-being, I believe that a plication is a procedure to be seriously considered.

In conclusion, it may be stated that—

1. Eventration is attended by no definite train of symptoms, and is, in fact, often symptomless, though it is probable that a careful investigation of a series of cases would show that they were all below par physically, as in the case reported.

2. That it results from congenital defects in the left half of the diaphragm, or the left lung, or of both. That a small percentage of cases are undoubtedly the result of trauma, or follow acute infections, as a result of degeneration of the muscle-fibers of the diaphragm, or injury to the phrenic nerve.

3. That the physical findings are often identical with those of hernia, and a differential diagnosis can be made satisfactorily only by means of radioscopic examination, though a history of sudden onset of symptoms, following injury, is very suggestive of diaphragmatic hernia, rather than eventration.

4. That the most important and only uniform physical findings are: heart dullness to the right of the sternum; tympany on percussion; and gurgling heard over the precordial area. These symptoms are the same in hernia and eventration.

5. Rupture with hernia of the diaphragm is undoubtedly much more common than eventration; but it is probable that more cases of eventration are being overlooked than in the former condition, because of lack of symptoms, and also because of the fact that hernia is generally associated with severe trauma and severe physical disability, which often ends in death and the condition is found at post-mortem. In cases that do not die, the resulting disability and history are more apt to direct attention to the condition present than in eventration.

6. The finding of dextrocardia should always call for a careful examination to exclude the possibility of eventration.

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GANGLIONEUROMA

By RICHARD J. BEHAN, M.D., PITTSBURGH

BECAUSE of its great rarity and the paucity of information in the English literature, a brief review of the known facts concerning neuroma seems to be of value. Neuroma is seldom diagnosed before operation. This frequently is due to a lack of knowledge on the part of the surgeon as to the prevalence of this tumor. Perhaps if knowledge in regard to it were more general and slightly greater care were exercised in diagnosis, we would find the tumor to be much more common than is supposed.

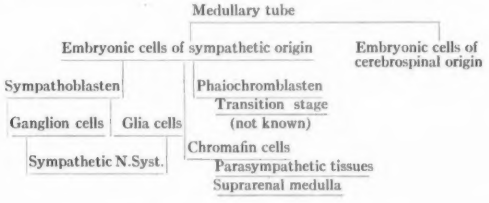
At first, the peculiar white, glistening, encapsulated tumors found in close relation to the adrenals and the sympathetic nerve-cords were thought to be sarcomata by the American and English observers (Dalton, Pitt, Orr, Parker, Pepper, Arnberg, Richards, Hutchinson, Tileston, and Wohlbach). They were supposed by some to arise in the suprarenals. Kuster, however, found that the intercellular substance was fibrillary and did not stain the same as the intercellular substance of sarcoma but did give the same stain-

ing reaction as glia; so because of the peculiar rosettes similar to those found in glioma, and the characteristic staining reaction, he grouped the tumors as gliomata.

While most of the authors agreed that the tumors were composed of nerve-tissue, there was, following the publication of Kuster's paper, considerable discussion between European pathologists as to the origin of these tumors. Finally J. H. Wright settled the controversy by proving definitely that they were of sympathetic germ-cell origin. Wright called these tumors neuroblastomata. He accounted for their presence in various locations by the accepted teaching that nerve-cells not differentiated have a tendency to wander out of the embryonic nervous system and form not only nerves and ganglia, but also the components of the sympathetic nervous system.

However, it was Pick and Bielschowsky who first prominently emphasized the close relationship between these tumors and sympathetic nerve-elements. They named them sympathoblastomata, or embryonic sympathetic gangliomata.

According to Poll this relationship of the tumors to the sympathetic may be diagrammatically shown in the following outline:



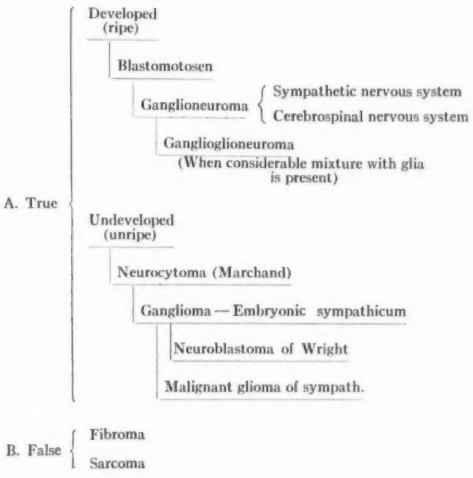
Tumors are known consisting of one or all types (except the pharochromblasten) of the above cells. These tumors in turn are but a subdivision of that great class of tumors called neuromata.

Neuroma, which is a general name for the entire class of the tumors under discussion, is divided into (1) true and (2) false.

The true neuroma is derived from specific nerve-tissue and is the result of hyperplasia of ganglion cells or of the new formation of ganglia. The false is not a neuroma at all but is rather a sarcoma or a fibroma.

According to Pick and Bielschowsky a neuroma consists of nerve-cells originating either from the sympathetic nervous system or the cerebrospinal nerves and ganglia. When the glia tissue is in abundance it is spoken of as a glioneuroma. Under the latter are included (1) pure celled neurocytoma of the cerebrospinal ganglia (Marchand); (2) ganglioma embryonic sympatheticum; (3) large-celled form of the area of the "Tuberosen Hirnsklerosa"; (4) neurinome (Verocays).

The relationship of the different classes of nerve-element tumors is shown in the accompanying diagram:



The first ganglioneuroma was described by Loretz in 1870. It occurred in an epileptic 35 years of age, and was found on the left side of the second and third thoracic vertebræ. It was an egg-shaped, smooth, hard tumor which evidently arose from the sympathetic. On autopsy, however, no communication with the sympathetic was observed. It is probable that Loretz did not recognize the definite relationship of his tumor to the nerve-elements, although he described the tumor as consisting of two layers: (a) the outer, dense, of connective tissue; (b) the inner, soft, consisting of numerous ganglion cells, partly separate and partly grouped.

In structure the ganglioneuroma is alveolar in type with septa of connective tissues

separating various sized masses of cells, poor in protoplasm but containing nuclei rich in chromatin. In some cases these collections have a rosette form and the cells are separated by a fine fibril intercellular substance. This intercellular fibrillary substance, as is shown by Pick, has its origin in the cells, several of the fibrils having been traced to individual cells. The more the fibrils and the cells become differentiated the closer will be the resemblance to tumors of glia, and then of fully differentiated nerves: the neurofibroma.

The following varieties of tumors have been described:

a. The sympathoblasten (Marchand and Hecht).

b. The group containing bundles of fine fibrils separating the cells (Pick, Landau).

c. The combination of the fibril masses with ganglion cells and nerve-fibers (Martius).

d. The ganglion cells with nerve-fibers.

If the intercellular substance is not markedly fibrillary, then the tumor resembles a small round-celled sarcoma, and so it frequently happens that the tumor in the neighborhood of the kidney which has little intercellular substance is mistaken for a sarcoma.

In the tumor mass, small cells similar to lymphocytes are seen in conjunction with very large cells. These small cells are (according to the views of Wright, Landau, Marchand etc.), the immature ganglion cells which later develop into the larger cells.

Vascularity. The tumor as a rule has but slight vascularity, so that it may be removed with but slight bleeding.

Location. Ganglioneuromata seem especially frequent in the lumbar region, where they originate from the embryonic cells of the suprarenal body. As is known, the chromatin substance of this body is of sympathetic origin, so that reasoning from analogy we would expect to find tumors of ganglion cells in locations where the ganglion cells are abundant, and have a tendency to become highly differentiated and specialized. This we do. They are found originating from the sympathetic ganglia (Landau, Pick), also from the sympathetic cords (Shilder, Landau) in the coccygeal gland (Alezais, Imbert).

According to Friedrich ganglioneuromata are most numerous in the sympathetic cords and ganglia of the abdominal cavity. Next are the sympathetic ganglia and the medulla of the suprarenals.

They also have been found in the brain (Schminke, Pick, and Bielschowsky), in the cord (Pick), in the dura mater at the superior orbital fissure (Haenel), in the gasserian ganglion (Marchand and Risel), in the retrobulbar part of the optic (Perlo), in the capsule of the knee (Hagenbach).

Incidence. Ganglioneuroma is more frequent on the left side of the body than on the right: 13 out of 16 cases. As a rule it is only a solitary tumor; however, in some instances, metastases have occurred and in one case Henecke found more than 160 tumor nodules. In another case (Miller) metastases were found in the neighboring lymph-glands, and in another, metastases were found in the liver (Jakobsthals).

Ganglioneuroma is more frequent in women than in men (63 per cent) and in the first 20 years of life. The following is a summary of the age incidence:

1 to 10 years	8 cases
10 to 20 years	9 cases
20 to 30 years	4 cases
30 to 40 years	6 cases
40 to 50 years	1 case
Over 50 years	4 cases

The oldest was 76 years (Weichselbaum). The youngest was 3 months (Busse and Fabris).

Symptoms. There are few, if any, clinical symptoms of ganglioneuroma, the tumor being most frequently discovered on autopsy after the patient has died of some other disease. However, in many instances the tumor-mass has produced symptoms by pressure on the neighboring organs and nerve-trunks. In one case (Williamson's) the tumor was located on the sacrum and caused dysmenorrhœa—at the same time, the uterus was displaced and anteflexed. In a case of Busse the tumor filled the entire pelvis and reached to the margin of the ribs, so that involuntary passage of fæces and urine occurred. Most of the tumor, except a small piece under the ribs, was removed. In five years there was no return. In the case of Braun, the aorta was torn during the

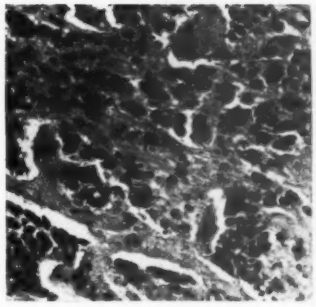


Fig. 1 (at left). Cross section of the tumor removed, ×300.

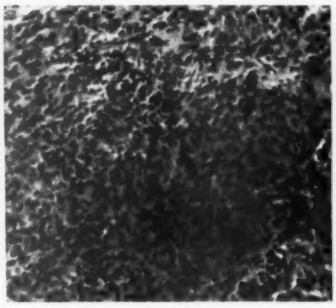


Fig. 2. Cross section of a glioma, ×250, occurring at the base of the brain. The nerve-cells and glial tissue.

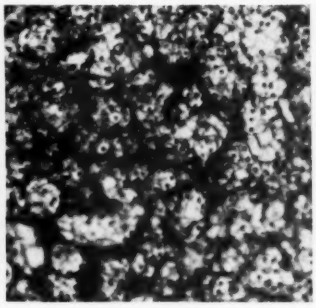


Fig. 3. Is a cross section of a Granitz tumor, ×250.

Both are inserted as means of comparison with Fig. 1.

removal of a large abdominal ganglioneuroma which was supplied by four large arteries from the aorta. The aorta was resectioned, the two ends united, and uneventful recovery ensued. In a case reported by Peters the tumor had pressed the kidney upward.

In the three cases in which post-operative collapse occurred, Celsner believed that a sympathetic shock with a vessel paralysis had occurred, with a consequent bleeding into the abdominal veins.

Especially characteristic of ganglioneuroma are the congenital origin, the occurrence in very early life, and the variation in malignancy. It generally occurs as a single tumor, although multiple tumors have been described by Knauss, Kredel-Beneke, and Risel.

Prognosis. As a rule there is little tendency to malignancy, though Landau believes that the younger the individual the greater is this tendency. The malignancy seems to be reduced in those cases which show a great variety of cellular elements. The greater the tendency to infiltrate and the less the differentiation of the cells the greater is the malignancy. Metastases may occur in neighboring lymph-glands or in the liver (Jakobsthals).

Treatment. The only treatment is free and complete removal. If the entire mass cannot be removed without danger to the patient, as much as possible should be cut away. Cures sometimes follow such removals.

My case of ganglioneuroma was referred to me by Dr. H. The patient was a well nourished female infant of 19 months. The chief complaint was a swelling in the left lumbar region which appeared six months previous and followed (?) erysipelas. The infant was otherwise normal.

The mass was seen to vary in position during respiration, becoming more prominent during inspiration and less prominent during expiration. On palpitation the mass was definable as a tumor about the size of a small apple, could be pushed up under the ribs, and was not tender or elastic. On crying, the mass was again pushed down. The vertebræ were apparently normal; no kyphosis or scoliosis, and no tenderness. The abdomen apparently was normal.

Diagnostic remarks. From the history and physical findings it was extremely difficult to make a diagnosis. The most probable hypotheses were that the mass was either a lumbar abscess connected with the kidney, or a tumor of the kidney itself. In view of the rarity of tumors in the adrenal or of the kidney (with the exception of the cystic degeneration) in children, we naturally were inclined to think more of the possibility of an encapsulated abscess. Puncture was made into the mass and only a very minute quantity of straw-colored fluid was removed. Examination disclosed some amorphous crystals. This result rendered rather more vague and indefinite the diagnostic conclusions, so that the patient was finally referred for operation with the diagnosis of lumbar tumor, probably connected with the kidney.

Operation May 11, 1915. Ether anæsthesia. Incision three inches long and parallel to and three-fourths inch from the last rib on the left side. Incision was made through the latissimus dorsi and subjacent facia. A small nodular mass presented through an opening between the quadratus lumborum and the abdominal muscles. The peritoneal fold was attached to the anterior part of a presenting tumor. The growth was evidently immediately posterior to the peritoneum, and its development had pulled the peritoneum down with it. After considerable

difficulty, because of the dense adhesions, the mass was freed from the adjacent structures. It was attached rather loosely by an apparently fibrous band of tissue beneath the transverse process of the second lumbar vertebra. This adhesion was separated; no ligatures were required as there was but little bleeding. This mass was capsulated and was about two inches in diameter. Neither the kidney nor the spleen were palpable. The wound was closed by catgut approximation sutures, the skin by silkworm-gut, and gauze drainage was introduced.

On June 1, 1915, the patient was in good condition; on June 11 the drain was removed; there was a slight red, thin, discharge (retained blood). The wound discharged a thin serous fluid for about one month. At the present time the patient is perfectly healthy and is gaining in weight.[1]

Through the kindness of Dr. Klotz of the Pathological Department of the University of Pittsburgh, I am able to furnish the following report on the specimen submitted:

On macroscopical examination the specimen is seen to consist of a lobulated mass of tissue 5 x 4 x 1.75 cm. The specimen was flattened, the surface being more or less lobulated and apparently covered by a capsule. The opposite surface was clean cut by the knife, and did not present the natural characteristics. The capsule was quite thin; the cut surface showed a glistening grayish-pink structure in which a glassy looking central fibrous tissue radiated to the periphery. The tissue showed a fine granular material between the fibrous tissue, which furthermore showed small grayish specks or granules. The tissue did not appear very vascular nor was it friable.

On microscopical examination the sections of the tissue showed a very interesting tumor. There was a great deal of fibrillar material which was pink staining and was arranged in tracts or columns. These tracts when closely examined showed many fibrils very closely arranged. In such tracts only occasional small, mononucleated cells were found. These cells had a round nucleus, a fair amount of protoplasm, and occasionally fibrils could be seen attached to them. The tracts of fibrils when cut in cross section consisted of granular looking areas, or a fine stippling indicating the cross section of individual fibrils. In areas other than these tracts there was also a ground substance of pink-staining fibrils, in which, however, were scattered numerous cells of irregular shape and size. In general these cells were unusually large, having one or more nuclei and a clear homogenous protoplasm. Some of the largest cells contained twelve or more nuclei. Some of these cells were round, others pear-shaped, while still others were irregular. From the pointed protoplasm of the cell, long processes could occasionally be made out. Some of these appeared to continue into fibrils.

Scattered among the cells were also seen homogenous hyaline bodies of circular contour. Here and there calcified masses were found in the stroma. By Mallory's method it was demonstrated that the connective tissue was relatively small in amount, while an intricate interlacing of reddish staining fibril could be seen in large quantities. The intimate association of large cells of the tumor mass with the numerous fibrils could also be demonstrated. There was no evidence of the presence of myelin sheaths about the fibrils. The diagnosis was ganglioneuroma.

[1]The patient has recently died of scarlet fever. Autopsy was not permitted.

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THE APPLICATION OF THE BONE-GRAFT IN THE TREATMENT OF PARTIAL OR COMPLETE AVULSION OF THE ADOLESCENT TIBIAL TUBERCLE (COMMONLY REFERRED TO AS OSGOOD-SCHLATTER'S DISEASE)

A New Operation[1]

By ROBERT E. SOULE, M.D., F.A.C.S., New York
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THE object sought in the treatment of partial or complete avulsion of the adolescent tibial tubercle is the early encouragement to ankylosis of the fractured portion of the tubercle beak to the tibia, which I have accomplished by pinning the broken fragment of the beak directly to the tibia by a bone-graft pin. The simplicity of application, the great shortening of the usual necessary period of treatment, and the certainty of an early cure of the condition lead me to offer this method as one which has served me most satisfactorily.

This condition is always the result of trauma, either by direct injury, as in falling on or striking the tibial tubercle, or by indirect violence through a sudden powerful contraction of the quadriceps muscle, as might occur in the various athletic sports where a sudden and severe strain would be placed on the quadriceps muscle in an effort to maintain the leg in extension such as might be experienced in football, jumping, wrestling, etc. This condition is always found in adolescence before bony union of the tibial beak and tibia has taken place. An injury simulating this during later life would consist of a direct rupture of the patella ligament, which is rare. The fracture of the patella itself is more common. This lesion is sometimes mistakenly diagnosed as osteitis of the tibia or as tubercular knee-joint disease.

The quadriceps muscle, one of the most powerful extensor muscles of the body, is attached below to and about the patella, from which strong fasciculi of tendonous fibers are prolonged into the strong band of the patella tendon, joining the patella to the tibia in the form of a very strong band of tendon-fibers, a portion of which fibers are attached directly to the tubercle, the sprayed-out fibers being attached to the roughened bony ridges of the upper anterior surface of the tibia. Somewhat overlying the direct fibrous attachment of the patella ligament to the tibial tubercle is a bursa, in and about whose walls pass some of the direct tendinous fibers of this patella ligament as they pass to their attachment to the tibial tubercle. As a sudden overstrain to the quadriceps muscle is felt first by the direct patella ligament fibers, these are the ones to become ruptured first; or, if their bone attachment is not sufficiently ossified, this portion of the prolongation of the epiphysis of the tibia is partially or completely separated, producing a partial or complete fracture of the tubercle.

Upon the degree and extent of the strain produced by the contraction of the quadriceps muscle depends the amount of the rupture of these fibers and the partial or complete avulsion of that portion of the ununited or partially ossified beak of the epiphysis of the tibia. Where the strain has been sufficient only to break the attachments of the central or direct fibers, the power of extension of the leg by the action of the quadriceps muscle may still be maintained through the unruptured lateral fasciculi of the patella tendon remaining attached to the tibia about the tubercle, and the X-ray will show only a partial separation of the whole tubercle or the breaking out of only a small portion of it. But where the violence has been particularly severe, a complete fracture and avulsion of the tubercle beak upward takes place, severing the continuity not only of the attachments of the direct fibers of the patella tendon, but also of its lateral strong sprayed-out fibers.

The incomplete separation of the patella

[1] Presented before the New York Academy of Medicine, Section on Orthopedic Surgery, January 21, 1916.

Fig. 1. Photograph of case before operation, showing prominence over tibial tubercle beak as the result of fracture.

tendon from its attachment is by far the most common and results only in partial disability to the limb. An important factor associated with this condition, and one which would seem to be the chief cause of the pain and discomfort experienced in many of these incomplete cases of avulsion, lies in the traumatism to the bursa overlying the tubercle. This bursa I have found at operation enlarged and tensely distended with bursal fluid. Pressure over this tense bursa before opening always produces pain, accompanied at times by a slight increase of local heat, as is associated with bursitis. This tenderness lasts longer than would be experienced from the simple rupture of tendon-fibers or the separation in continuity of a portion of the tubercle. Then, again, the local swelling is greater and persists longer than would be looked for in such a trauma. So it would seem from these findings that a low-grade inflammation of this bursa is produced, kept up by the attempted use of the limb until the fixation of the ruptured fibers is had, the contraction of the quadriceps stopped, or the ankylosis of the fractured tibial tubercle to the tibia completed.

The consensus of the findings in these cases as to recovery from the injury places the time from six months to two years. If the milder degree of damage has taken place and the diagnosis is made shortly after the injury, a few weeks of local treatment suffices, such as fixing the leg in extension with strong compression over the tubercle by crossed adhesive strapping. In the most severe cases where partial or complete fracture of the tubercle has taken place and in cases of late diagnosis, symptoms of pain, tenderness, and partial disability having persisted for several weeks or months, or in spite of local treatment, then more radical measures should be resorted to.

There was referred to me at the Post-Graduate Hospital a case of a boy, T. G., 14 years of age, who a year previous had fallen, striking the left knee on a stone. Pain, localized tenderness, and swelling were acute following the injury. No particular attention was given to the injury other than rest to the joint. The condition improved but was not entirely relieved. It was noted that there was a decided localized lump and tenderness on pressure which persisted. He was unable to kneel on the affected knee and there was a limp in walking, and in going upstairs he experienced pain and weakness in the knee. He was unable to run with the freedom he had formerly, and he stated the left leg seemed decidedly weaker than the right.

My examination in October, 1915, one year after the injury, revealed the localized enlargement at the site of the tibial tubercle, tenderness on pressure, weakness and discomfort in attempting voluntary strong extension of the leg, a slight limp in walking, slight increase of local temperature appreciable, no joint involvement. The X-ray showed the separation of a portion of the beak of the tubercle. As the clinical symptoms had persisted for so long a time, and as relief by the conventional methods heretofore adopted promised no speedy cure, I decided to apply a new method: that of pinning the injured beak to the tibia by means of an autogenous bone pin to stimulate osteogenesis and furnish a medium through which an earlier bony union of the beak to the tibia could take place and thus strengthen the tibial tendon attachment, which operation I performed in October, 1915.

A curved skin incision about the affected area was made and the flap turned to one side, exposing the bursa and tendonous attachments. The bursa was found tense and distended, and upon incising it the bursal fluid escaped as if under pressure. The bursal walls showed increased thickness. Carrying the incision through the bursa down through the tendinous structures to the bone with a ⅛-inch drill attached to the electric motor, a hole was made about ¾ inch deep, penetrating through the broken beak into the tibia. Through a skin incision 1½ inches long over the antero-internal surface of the tibia of the same leg, a bone strip one inch long was sawed out with the motor twin saws separated ¼ inch from one another and cut at each end by a small motor circular saw to free the bone

Fig. 2. Roentgenogram of leg before operation. Note excavation in the tubercle, the absent bone substance having been torn out by detached tendon-fibers.

Fig. 3. Roentgenogram of Fig. 1, showing autogenous bone pin in position, uniting the tubercle to the diaphysis of the tibia.

section. This strip of cortical bone was lifted out of the tibial surface by the aid of a thin osteotome and then run through the electric dowel shaper to form a peg ⅛ inch in diameter to fit the hole previously drilled. The bone-peg graft was driven into place and the excess cut off with the small motor saw flush with the bone surface. The skin wound was closed with plain catgut without drainage. No fixation dressings to the knee-joint were employed. The wound healed by first intention and the patient was up on crutches in two weeks. In three weeks all tenderness on pressure was relieved, and the patient was walking in six weeks, with all symptoms relieved. The leg has regained its normal strength and usefulness and the patient remains entirely free from all symptoms.

CYLINDROMA OF THE TONGUE

With a Report of Two Cases

By ROBERT H. BAKER, A.B., Ann Arbor, Michigan
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CYLINDROMA, characterized by hyaline formations of typical arrangement, has been described in the textbooks as having the following clinical characteristics: It is located about the head, especially about the orbit, the salivary glands, nose, antrum of Highmore, and the mucous membranes of the cheek and gums. Its growth is slow, recurrences are frequent, but there are no metastases. Except for some forms described that seem to include a distinctly sarcomatous element, the tumor seems to be relatively benign. Some confusion exists from the fact that some quite different tumor forms have displayed some of the same hyaline characteristics, and also because of the lack of agreement in defining the term cylindroma and endothelioma.

Several cases that may be described under the title cylindroma have been discussed in the literature. In general the majority of observers have classed the growth as an endothelial form of connective-tissue tumor. Some difference of opinion exists even on this point, some men choosing to explain the hyaline structure to be described later as a product of mature connective-tissue elements. Others like Lubarsch (1) believe the form originates, not from the endothelial but from the perithelial cells of the blood and lymph-vessels. The most widely held opinion is, however, that the tumor is an overgrowth of endothelium lining lymph and blood-vessels, and that the hyaline so generally described is either a degeneration product or a secretion product of these cells. This latter point has not been so widely discussed.

In 1912, Dr. Oberlin (2), in a concise and thorough review of the cylindroma question, reported three cases from this laboratory which she described as cylindromata. In that report she considered all the literature to date stating the prevailing theories of origin, development, and classification of this relatively rare form. Two of the three cases which she reports came from the head with a history of 15 to 30 years growth. These she describes as endotheliomata. The third case from the uterus, of rapid growth, exhibits a mixed type with a sarcomatous element. In 1914, Baumgartner (3) in discussing "*la pathogenie du cylindrome*," takes this view: that the cylindroma is a mixed tumor consisting of epithelial and mucoid elements existing side by side and with a predominance of the mucoid material. A further discussion of his views will be considered later in this report.

The especial interest attached to the two cases in hand is the fact that in all cases described in the literature to date, none has been mentioned as coming from the tongue. Both tumors were received at the Pathological Laboratory of the University of Michigan within a period of less than two months and present nearly identical features.

Case 1 (4) must be discussed only in the light of its microscopical appearance as no history was obtainable. Case 2 (5) occurred in a woman, age 30. Two years previous it began as a thickening on the right dorsum of the tongue. It grew slowly until about three months before removal at which time it became painful and grew more rapidly. No adenopathy occurred with the growth and it was removed entire with its capsule.

In the gross, Case 1 appeared somewhat bilobed with a dimension of about eight millimeters in its two smaller diameters and twelve in its greatest dimension. Case 2 was somewhat larger and existed as a single mass. Neither of the tumors was received in fresh enough state to express the hyaline tubes as has been described by some authors. Both tumors gave the hyaline glassy appearance usually described in the section of such growths, the descriptive name cylindroma coming obviously from the appearance of the

hyaline cylinders and balls on section in the gross.

Microscopically, the specimens present the following features: Enclosed within a thin but quite definite connective-tissue capsule within the muscle of the tongue, is to be seen the characteristic arrangement of curved and twisted hyaline strands, which, in serial section would form the cylinders and knobs described in the gross. In some parts of the tumor the hyaline patches are seen to include small nests and cords of cells which appear to be of the endothelial type—flat with rounded and ellipsoidal nucleii containing in some, apparently the most recently formed cells, a rather limited amount of chromatin material. These cells vary quite markedly in size, averaging somewhat larger than the endothelial cells lining normal lymph-spaces. The same type of cells is noticed in greater abundance arranged in nests and cords extending between the hyaline cylinders. The somewhat radial arrangement of these cells in reference to the hyaline cords is due, I believe, to contraction of this latter substance. A noteworthy feature is that the hyaline areas are almost exclusively bounded by these cells, suggesting the origin of the hyaline. A much less conspicuous element is the mature connective-tissue cell, which, with some small blood and lymph-vessels serves to make up the rest of the tumor. Special staining by Kresyl-Echt-Violett gives no staining reaction for amyloid or mucin. Van Gieson's stain gives the deep rose-red reaction characteristic of connective-tissue hyaline to the non-cellular glassy, material, and no reaction for mucin is obtainable.

Under higher magnification, certain quite distinct markings within the hyaline material suggest the outline of large flat cells from which the nucleus has degenerated. This conception is further substantiated by finding here and there a definite cell inclusion within the hyaline, showing the complete cell outline but with the space vacuolated and a contracted pyknotic nucleus at one side. By careful search such cells are seen in all stages of disintegration, even to the point where the nucleus has lost its contour and only a remnant of chromatin remains within a cell boundary. This same cell may show an imperfect wall and may enclose what appears to be a beginning infiltration with the hyaline which I assume to be a secretion of this or other cells about it.

The connective-tissue elements in both the tumors at hand show a marked hyaline degeneration, but it is quite impossible to trace the relation of this tissue to the hyaline of the cords. The tumors show some small blood-vessels with markedly sclerotic walls while others farther removed from the hyaline cylinders are quite normal in appearance. One of these tumors presents a somewhat different picture *en masse* than the other, a difference which I interpret as representing a younger stage of the growth of this peculiar tumor form.

In the first case one is struck by the profuse vascularity of the growth, the conspicuous element being the large number of dilated lymph and blood-capillaries and spaces. The ramification of the capillaries is easily made out as they stand out sharply, often containing a line of red blood-cells. The hyaline cords are not in this case so large or so definitely circumscribed as will be described in Case 2. The connective-tissue elements are much less conspicuous, as they are so scattered among the lymph-spaces, and have not, in this younger stage of the tumor, undergone the same degree of sclerosis and hyaline change, which is so much more evident in the second case as a result of the restriction of blood and lymph supply. One is impressed, however, by what seems to be a significant fact. In certain areas where the sections show most clearly the curling and branching of capillaries in a single plane, one can see between the unbroken endothelium and the connective tissue which makes up the framework of the tumor, small areas of the hyaline which from its very relation suggests that it is a secretion product of the endothelium. Where the massing of this material is more marked one sees that the lumen of the spaces is correspondingly restricted until we have in some fields the small cell inclusions referred to above. This peripheral distribution of hyaline I believe to be but a chance one, as in other fields one is equally attracted

by the fact that the hyaline strands are definitely included within a single line of endothelium and contain no cell inclusions, the hyaline substance here being quite certainly a secretion within the lumen of the capillaries.

In the second case, one is struck by a more characteristic appearance of the hyaline tubes. Here we have the same cellular elements as described above, but in somewhat altered proportion and arrangement of these. There are seen definite trabeculæ of connective tissue to form a framework, including capillaries of large caliber. Both these factors are markedly sclerotic. Within the enclosure of these trabeculæ is seen the much twisted and whirl-like arrangement of the hyaline cords. The structure here is not essentially different from that in Case 1, but we notice a relative lack of connective tissue fibers and of capillaries and lymph spaces seen above. But here the hyaline cords are larger and do not show the earlier stages of cell degeneration. The distribution of hyaline, too, is generally one of secretion within the lumen as evidenced by the external lining which these cords show.

The interpretation to be made then from these observations is this:

1. That the tumors in question arise from abnormal proliferation of blood and lymph capillaries and spaces.

2. That the endothelial lining of these capillaries and spaces gives rise to a secretion of some material which gives the staining reaction of connective tissue hyaline.

3. That this hyaline substance receives a chance distribution centrally or peripherally to the secreting cells.

4. That the excessive proliferation of the vascular elements meeting the resistance of the firmer connective-tissue framework and of the increasing resistance of the hyaline material, tends to assume a much twisted, curling, convoluted structure.

5. That the increasing tension within these convolutions from proliferation and excessive hyaline formation, causes first a shutting off of the vascular supply to the tissue and ultimate necrosis of the endothelial cells and tends also to restrict the nutrition of the connective-tissue elements with resulting sclerosis and hyaline degeneration.

That the tumors are not of connective-tissue origin, I think is proved in that they quite clearly are associated with endothelial structures and in all stages show no relation to the connective-tissue elements they enclose. Any degeneration of connective-tissue stroma which may be demonstrable in these tumors, I believe to be but secondary to a primary change in the endothelium in contradistinction to the view of Ewetsky (6).

That the hyaline secretion is not perithelial in origin as Lubarsch states, I believe to be evidenced by the fact that these hyaline inclusions are seen to be within an endothelial boundary in the greater part of the growth.

Baumgartner, following the view of Malassez, thinks the cells composing the main part of this form to be epithelial. He further thinks these cells exist in conjunction with a mucoid substance. The preponderance of this latter element he explains as due to the greater vitality of the mucin over the epithelium. He further explains the growth as centrifugal in its course. That the cells are epithelial he attempts to prove by the fact that they do not seem to him to have any connection with the blood-vessels. He describes them as being atypical in the center, but showing the characteristics of cuboidal and columnar cells at the periphery of his sections. They do not show signs of being secretory so therefore he concludes that the mucoid substance is not a secretion of these cells, nor is this substance a degeneration or a vegetative development of these cells. By staining reactions he is satisfied that the material is not myxomatous but true epithelial mucin in nature. In a review of 400 cases described as cylindroma he chooses 83 as true to the type. Seventy-four of these are described from the head, three from the sacral region. He explains the presence of mucoid tissue as an embryonic remains similar to the vitreous of the eye, and cites the existence of 23 cases from the orbit to substantiate this relation. The description of cylindroma-like areas in teratoids lends further weight to his theory of the embryonic origin of this substance. That the epithelial relation of the cells in these tumors is not valid, I can only combat with the evidence which I have offered.

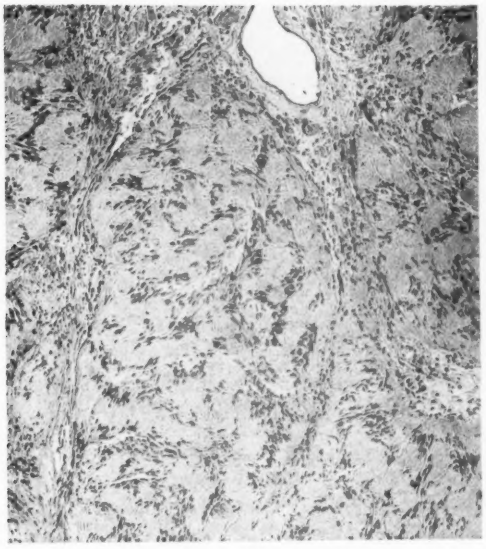

Fig. 1. Cylindroma of the tongue (low power), showing characteristic appearance of the endothelial-cell cords and nests and the hyaline cylinders and knobs.

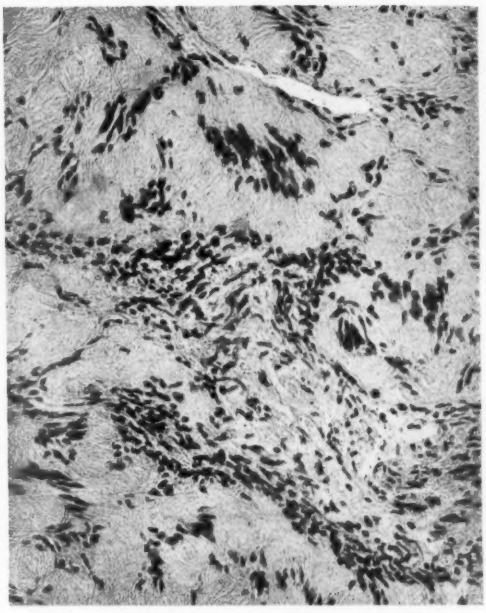

Fig. 2. Cylindroma of the tongue (high power), showing the relation of connective-tissue stroma to the endothelial cells and hyaline tubes, and the intimate relation of the hyaline to the endothelium of capillaries and lymph-spaces.

Moreover, following the analogy of this mucoid substance with the vitreous we must look for a cell-matrix which will be the origin of this mucin just as the vitreous takes its origin in the epithelium of the posterior zone of the ciliary body. That the substance is not mucin is certain in these two cases and that it is a secretion of the cells seems a logical conclusion though the secretory power of these cells cannot be proved. The underlying idea of Baumgartner and others that these tumors are possibly embryonic in origin and assume a development during extra-uterine life, is a conception which seems quite tenable.

That the cylindroma may be described fitly as a tumor entity, I believe is justifiable because of the fact that several of the cases described under this title have shown no clinical or pathological relation to either carcinomata, sarcomata, or enchondromata, as believed to be the case by Foerster (7), R. Volkmann (8), and R. Maier (9). A recent report by Richard Weil (10) of a parotid tumor which he has considered as an example of cylindroma, gives evidence of the frequently mistaken identity of this tumor form. The clinical history of his tumor might fall well within the limits of the cylindroma, but his brief discussion of its histological nature and his photomicrograph certainly do not conform to the type of tumor I am describing as cylindroma. It is undoubtedly such degenerative forms of epitheliomata that have so complicated the exact classification of the cylindroma. Cylindroma is a descriptive term. But the cell of the cylindroma does not partake in character or arrangement of the features of the basal cell. Dr. Oberlin's Case 3, from the uterus, is also an example of a malignant growth with degenerative areas of the nature of cylindroma. Such cases should, I believe, be called sarcoma cylindromatosum to express this resemblance to cylindroma. True cylindromata show few degenerative changes, in some cases mucin being demonstrable. On the contrary, they seem relatively benign and evidence microscopically only the arrangement and elements described above.

Fig. 3. Cylindroma of the tongue. The dense connective-tissue capsule is shown enclosing the tumor and separating it from the tongue muscle.

The exact nature and origin of the cylindroma which will lead to its final classification among tumors must remain undecided. I believe, however, that the evidence submitted in my cases combined with that of similar reports, points to a logical conclusion. In the belief that the endothelium may take part in the formation of sarcomata, the cylindroma should be considered as a variable form of sarcoma, according to Borst (11). True cylindroma is not clinically or microscopically of the character of sarcoma, however. The tissue is not sarcomatous and not infiltrating, but is sharply circumscribed by a connective-tissue capsule. If then we consider this form as essentially endotheliomatous, in what does it take its origin? From the cases of true cylindroma described in the literature, we are struck by the benignity of the form. The clinical history usually is that of a slow growing nodule lasting over a period of years. The one history which I submit may seem to indicate an exception to this statement. We cannot be certain, however, that the history of more rapid growth in the last three months, is not due, in this case, to some degree of inflammatory infiltration due to the mechanical irritation of the tumor proper. Considering then the long history, the benignity, and the simplicity of the tumor-element — a connective-tissue hyaline on a base of capillaries — it seems logical from pathological experience, to consider this of the nature of angioma, simplex or perhaps hypertrophicum. In this event cylindroma may be described as of embryological origin, of a type of angioma, assuming its clinical characters usually some time in adult life. The hyaline may be believed in this case to represent some sort of an attempt on the part of the body at a reparative process in the existing angioma.

Further evidence as to the duration of growth, location, clinical manifestations, and microscopical characters, in young forms alone, can give this tumor its definite place in the classification of tumors. Until then it may quite logically be considered under the title of cylindroma, endothelioma cylindromatosum, or angioma cylindromatosum.

I desire to express my gratitude to Drs. Warthin and Weller for valuable assistance and advice in making this report.

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DEPARTMENT OF TECHNIQUE

FLUOROSCOPIC ROENTGEN INJECTION OF THE BLADDER

By E. H. SKINNER, M.D., Kansas City, Missouri

ROENTGENOGRAMS of the bladder filled with opaque emulsions, air or oxygen, have been frequently reported. Such roentgen examinations are of great value in vesical diverticula, intravesicular tumor, enlarged prostate, etc.

There are certain advantages to these roentgen examinations if the opaque injections are made under fluoroscopic control. It is extremely simple for the patient to lie upon the horizontal roentgen table with the fluoroscopic screen directly over the bladder area as the opaque emulsion is slowly injected into the bladder through a catheter by means of a large plunger syringe, or by the gravity method.

The gradual enlargement of the opaque bladder shadow is witnessed fluoroscopically, the patient being turned from one side to the other in order to note the location of diverticula upon the posterior or anterior bladder-wall. The transverse bladder shadow may be obtained also, and is especially valuable in dilatations of the bladder anteriorly and upward or in cases suspicious of a patent urachus.

In the case herewith reported, No. 6345, Mr. O'N., referred by Dr. Denslow, the provisional cystoscopic diagnosis was a diverticulum near the position of the left ureteral orifice, which could not be entered with the cystoscope for visual exploration.

The patient lay upon the fluoroscopic roentgen table with the knees slightly flexed over a pillow. The catheter was inserted to the bladder and a large syringe filled with barium emulsion was attached to the catheter. The fluoroscopic screen was placed over the bladder area anteriorly and the roentgen tube focused underneath this area.

As the emulsion was gently forced into the bladder by the syringe the opaque shadow grew apace. After 16 ounces of opaque emulsion had been injected, no diverticulum having been observed upon the lateral bladder-walls, the patient was rotated to the right and left sides and still no diverticular shadow presented itself. Viewing the patient laterally one noticed the projection of the bladder anteriorly and above the symphysis pubis with a serrated outline to the bladder-wall, but no diverticulum was apparent.

When the patient was returned to the original position upon his back, we noticed a long opaque shadow extending upward from the left superior portion of the bladder shadow in the usual position of the left ureter. This broad shadow extended above the pelvic outlines toward the left kidney (Fig. 1).

Roentgen negatives were then taken in several positions and this long shadow interpreted as a dilated left ureter. The opening in the bladder-wall which was thought to be the mouth of a diverticulum was no doubt the enlarged orifice of the dilated left ureter.

Fig. 1. Shows long opaque shadow extending upward from left superior portion of bladder shadow in the usual position of the left ureter.

This method of fluoroscopic injection of the bladder is valuable in suspected diverticulosis because so frequently the diverticula are behind the full bladder shadow and the best position for radiography can be secured with the fluoroscope, thus avoiding unnecessary delay or repetition of the bladder injection as when radiography alone is practiced.

AN UNUSUAL HYDROCELE CONTENT

By Dr. JOSE EDUQUE, Manila, Philippine Islands
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THE case I am presenting in this paper is not a new one; it is, however, interesting on account of findings met with after the vaginal sac had been opened up. The case history is as follows:

Case 35,481. Perfecto Cuevas, male, Filipino, age 40, born in Imus, Cavite, came to Philippine General Hospital on April 28, 1915. Complaint, right-sided enlargement of scrotum. Habits, smokes 30 cigarettes per day. Family history, unimportant. Past history. Smallpox and dysentery while young; occasional fever and cough also; alveolar abscess and œdema of lower extremities fifteen years ago. No venereal disease.

Present illness. Began about fifteen years ago as a small, soft, fluctuating mass situated at the right side of the scrotum which gradually increased in size until it attained its present volume. This enlargement of the scrotum has never been accompanied either by pain or tenderness. The patient never noticed the scrotum to get smaller on lying down nor to get bigger on walking.

Objective examination. He is a fairly well developed and nourished man as he lies on the bed and is able to be up and around with nothing of importance on examination except the scrotal lesion.

Local examination. Right scrotum is about 10x8 cm. in size, soft and fluctuating. It is oval in shape and could be easily moved up and down. Other superficial vessels are prominent and enlarged. The right testis could not be found. The left testis was apparently normal. On percussion, slight tympany could be elicited above while dullness was present elsewhere. The sac seemed to be not entirely filled with fluid.

Laboratory findings. Stool: trichuris. Urine: reaction, acid; sugar, negative; albumin, decided trace; few renal epithelial cells, leucocytes and mucus (April 27, 1915).

Operation. May 4, 1915: An incision about 6 cm. long, on the anterior surface of the scrotum was made. A sac was encountered containing the stomach, cæcum, about

Fig. 1. Before operation.

Fig. 2. Before operation.

Fig. 3. After operation.

6 feet of jejunum and duodenum all plastered together. During manipulation one loop of intestine was incised. This was sutured with linen. The appendix was found to be big and long and bound to the posterior surface of the cæcum by adhesions. After separating all the adhesions and removing the appendix, the extruded viscera, were reduced into the abdominal cavity. The redundant part of the vaginal sac was cut off and the remaining turned inside out. A few interrupted catgut stitches were placed behind the testis to hold the cut edges of the vaginal sac in apposition. A closure of the external abdominal ring was made to prevent a future protrusion of the intra-abdominal content into the scrotal cavity. The scrotal wall was closed with a cigarette drainage through a separate counter opening.

After-treatment. May 6, 1915: Very severe reaction. The scrotum is just as large as before the operation and hard. Plenty of bloody and serous fluid coming out through the drainage. Scrotum is elevated. May 12, 1915: Enlargement of the scrotum is decreasing. Amount of oozing is also less. May 15, 1915: Unimportant amount of oozing. Drainage removed. May 17, 1915: Scrotum much smaller. Serosanguinolent oozing still present although in very small amount and feels much better. May 20, 1915: Wound healing. May 22, 1915: Scrotum much smaller every day. Patient feels very well. Able to be about. May 27, 1915: Patient getting stronger. June 6, 1915: Patient feeling very comfortable. June 20, 1915: Patient complains of fever and pain in the scrotum. A hot compress of aluminum acetate solution was applied to the scrotum and changed very frequently, made the pain subside and the fever disappeared.

As his hernia in the right groin has not yet been repaired and the patient is desirous of recovering from his ailment, he was operated on for the second time.

July 27, 1915: Herniotomy, right side, after Fergusson. August 6, 1915: Stitches removed. Wound superficially infected (due possibly to suture material). A small sinous developed and has been drained. Dressed every day.

After the patient has been completely cured of this superficial infection, a photo was taken, Fig. 3, to compare with that before the operation Fig. 1 and 2.

Pathological report: May 11, 1915: Specimen is that of an appendix measuring 6 cm. in length. Externally it is reddened and the whole is soft. It contains thin, yellow-colored fæcal material. Diagnosis: chronic catarrhal appendicitis (Manlove).

Post-operative diagnosis: Hydrocele, of the right testis. Direct, complete, inguinal hernia. Visceroptosis. Chronic, catarrhal appendicitis. Intestinal adhesions. Trichuriasis.

The accompanying pictures, Figs. 1 and 2, show the state of the scrotum of the patient soon after he was admitted to the Urological Service of the Philippine General Hospital Surgical Department. As is seen in these pictures, the enlargement of the scrotum is so remarkable that it almost touches the inner and upper part of the knee-joint. The veins are so beautifully distended that they constitute a net-work easily seen with the naked eye. The enlarged scrotum is distinctly fluctuating. The right groin is flat although a little bit more elevated than the left. In the inner aspect of the scrotum and upper part of the same just below the glands penis, a small bulging is noticed which corresponds to the left testis. The right groin is also fluctuating, although the fluctuation is not so distinct as that of the scrotum. Before the operation, a diagnosis of hydrocele of the right testis with possible hydrocele of the cord had been made. An operation was advised and agreed upon.

On performing the operation, the writer was surprised to encounter conditions beyond expectation, as are expressed in the post-operative diagnosis.

A BLADDER SUTURE

By ALEXANDER HAMILTON PEACOCK, M.D., Seattle, Washington

ALL who have attempted surgery upon the bladder have had more or less difficulty in closing the viscus, either watertight or around a drainage tube.

The causes of this difficulty are (1) the distance it lies from the primary incision (skin), the bladder lying quite low in the pelvis especially in men who have a thick abdominal wall; (2) the fact that in all but cases of a hypertrophied and dilated viscus, the bladder cannot be brought up to the initial wound as other pelvic organs can be; (3) that the bladder is a contractile organ and apparently shrinks into the size of a golf-ball; and (4) that after the bladder has once been incised, the incision is apt to develop into an uncontrollable tear, due to the insertion of the speculæ, instruments, or the fingers of the operator; and some bladders tear very, very easily. All these things contribute to making a closure of the bladder, at times, slow, tedious and embarrassing.

Anchor sutures. The most popular suture has been the pre-incision, anchor sutures, one on either side of the median line. They have been a great help, serving chiefly as tractors and elevators of the edges of the bladder wound. However, they frequently tear themselves loose and are of doubtful aid in the final closure of the bladder. To overcome these disadvantages, the following suture has proved most satisfactory, as it is easy to insert, easy to tie, and gives a perfectly tight wall.

Modified purse-string bladder suture. A perineal fish-hook needle is used as pictured in Fig. 1, *N*. Chromic catgut, size No. 2, twenty-day absorption is the best suture material. After exposing the bladder, retractors are inserted and the peritoneum pushed and rolled back off the upper side of the viscus. No matter whether large or small, full or empty the dome of the bladder always shows itself. This is grasped at two points in the median line with toothed forceps. Then a purse-string suture is started at the fundus, down the right side, then turned and run up the left side. It will be noticed that the stitch has a crenelated appearance, as each new bite into the bladder-wall falls into a different line, the object being to avoid bringing all the strain and pull on muscle-fibers of the same line and group. We aim at the same result with mattress sutures.

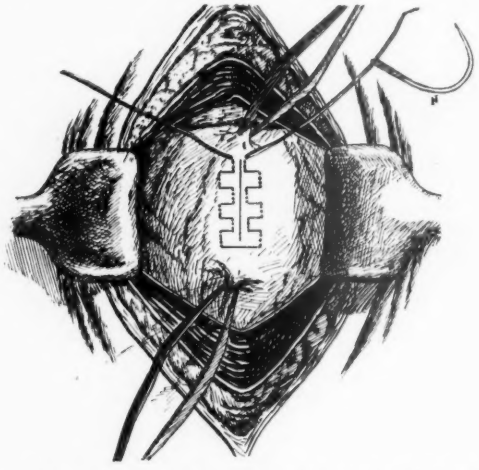

Fig. 1. *N* Perineal fish-hook needle; dotted and dashed line crenelated purse-string suture.

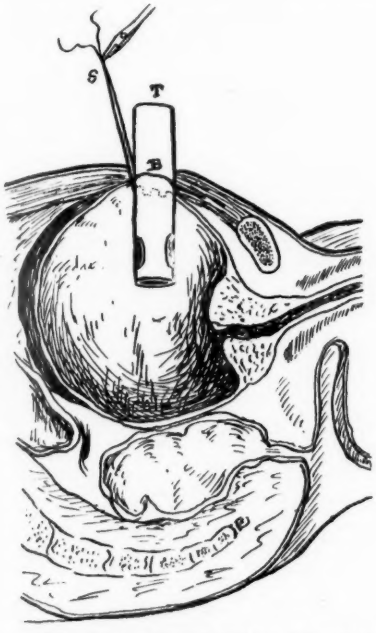

Fig. 2. *S* Suture tied around drainage tube; *T* drainage tube; *B* bladder-wall drawn tight against drainage tube.

The bladder is now ready to puncture. After completing the intravesicle work, a drainage tube can be inserted or a retention catheter placed in the urethra and the suture drawn tight. A reinforcing suture can be used, but is quite unnecessary, as the natural contraction of the muscles of the bladder wall further assist our purse string. A small cigarette drain can be used in the space of Retzius. This suture has been employed for simple drainage, exploration, calculus, retrograde stricture operation, resections for papilloma and prostatectomy, all with uniform success and satisfaction.

I can recommend its use for the following reasons:

1. It is easy to insert.
2. It stays in place and does not tear the bladder.
3. It lessens bleeding from the large veins in the bladder-wall.
4. It saves much time in closing up the bladder.
5. It makes a tight closure of the bladder possible, insuring a drier wound and better drainage.

PITUITRIN IN POST-ABORTION CURETTEMENT

By HENRY DAWSON FURNISS, M.D., F.A.C.S., New York

FOR the past year it has been my practice to give one cubic centimeter of pituitary extract, hypodermatically, before curetting for incomplete abortion.

The advantages in doing this are that it produces firm uterine contraction, which makes the procedure almost bloodless and much more easily done. Because of this contraction, the uterine cavity is small, and the contracted walls present a resistance to the curette, which makes their cleansing less difficult; and, I believe, lessens the risk of uterine perforation.

The most favorable time to give the pituitrin is 15 minutes before the actual curettement is begun. When the interval between the injection and curettement is less the resulting contraction has not been so pronounced, and the result not so good. As yet I have not had any post-operative bleeding following the use of the pituitrin, but realizing that such a possibility exists, it is advisable to pack the uterus and vagina with iodoform gauze, which is removed at the end of 24 hours. Should bleeding occur and be troublesome, ergotole can be given hypodermatically.

With the use of pituitrin the blood loss is so much less and the curettement so much easier than without that I strongly advocate its general use.

TRANSACTIONS OF SOCIETIES

CHICAGO SURGICAL SOCIETY

REGULAR MEETING HELD MARCH 3, 1916, WITH THE PRESIDENT, DR. S. C. PLUMMER IN THE CHAIR

DR. EDWARD H. OCHSNER read a paper entitled "The Bio-Chemistry of Topical Applications as Applied to Surgery."

DR. F. E. PIERCE read a paper entitled "Traumas to the Back and Spine" (See p. 332).

DISCUSSION

DR. DANIEL N. EISENDRATH: This is an exceedingly valuable paper to everyone of us, especially to those who hold important railroad positions. We are indebted to Dr. Pierce for bringing to us his carefully edited list of cases. I believe that we owe it to these patients, both from the standpoint of a defendant corporation and that of a patient not a claimant for injuries, to be exceedingly thorough in our examination and not regard the patients as malingerers. We are very apt to examine them hurriedly and pass them along as cases of sprained muscles, etc.

I have had occasion in the last two years to see a number of cases which were diagnosed as minor injuries, and yet the persistence of the symptoms caused me to make a most thorough examination. I wish to speak in this connection of fractures of the transverse processes of the lumbar vertebræ as being frequently overlooked, because we think that such things could hardly be possible from an injury of the back. A roentgenogram ought to be made of every one of these cases not only in the region complained of but of the entire spine, not only in an anteroposterior direction, but if possible in a lateral direction. Some of the cases of fracture of the ribs near the vertebral column are apt to be overlooked, and again there are cases of fractures of the fifth lumbar vertebra, crushing fractures, without any other symptoms than those of pain. There may be no symptoms on part of the spinal cord, hence it is almost impossible to diagnose them without a good roentgenogram.

Finally, I would speak of a superficial method we have of examining some of these cases which one of the histories reminded me of, and that is injuries of the urinary tract. I had occasion about two years ago to see a patient who had sustained an injury of the kind Dr. Pierce described, from lifting a heavy weight. The patient was from Grand Rapids, Michigan, and had passed from one practitioner to the other with a history of repeated colics. The colics were referred to one side and only by going into the history thoroughly did we find the colic started on one side of the back and radiated down the same as a typical ureteral colic. We made use of a method of diagnosis that I can warmly recommend to you, and that is to make a pyelogram, and in this case we found a stricture of the ureter an inch and a half below the pelvis of the kidney as the cause of this man's symptoms. Thinking there could be no connection between the injury of the back sustained by flexion or overextension of the back and injury of the ureter, we later proved by a pyelogram at operation that there was a hydronephrosis secondary to the injury of the ureter. So I would make an urgent plea for a more thorough examination in these cases, utilizing every method before passing them along as sprains or possible cases of malingering.

DR. FRANK E. PIERCE (closing): I have nothing further of importance to add. I purposely omitted fractures because it is such a large field.

The importance of making a careful examination in these cases, as emphasized by Dr. Eisendrath, cannot be urged too strongly. I have had a number of cases in which the diagnosis was made of sprain where the X-ray has shown a fracture of the transverse process, or a fracture of an articular process which had caused pressure on the spinal nerves and symptoms which our examination could not bring out except through an examination of the X-ray plate. It is easy enough to make a superficial diagnosis and say it is this or that, but if we are going to do justice to the patient we should be absolutely unprejudiced and give him the benefit of the doubt, if there is a doubt, as to the serious nature of his case.

DR. WILLIAM HESSERT read a paper entitled "Epiploitis Following Herniotomy" (See p. 297).

BOOK REVIEWS

A CRITIQUE OF NEW BOOKS IN SURGERY

By MAJOR G. SEELIG, M.D., Saint Louis

ONE of the best book reviews, I have ever read, (written by Walter Lippman), did not even so much as mention any specific book by title. The reviewer suavely granted himself the license to select a volume only to consign it to oblivion, by leaving it nameless; then, he proceeded to use it as a text, from which to preach a sermon on the meaningless mumble-jumble of much of our present day politico-sociological literature And after all, why it is not legitimate to do just this very thing? Why not, now and then, regard a book as the expression of a tendency rather than as a concrete product, to be measured and trimmed by the ordinary conventional standards?

At all events, this is the spirit that moves me after reading two new volumes by Crile.[1] Both these volumes are founded on the same material that has served as the basis for other books by Crile, already reviewed in this department. In these earlier reviews, we have expressed rather emphatic dissent, both from Crile's philosophy and from his logic. Of course, this is, after all, only a matter of judgment, and someone has said wisely regarding judgment: "'Tis with our judgment as our watches —none goes just alike, yet each believes his own." If Dr. Crile himself should take exception to our estimate of his philosophy and logic, he surely cannot cavil at our unqualified admiration of the tendency mirrored in these two latest and the two or three earlier volumes dealing with anoci-association.

But before stating this "tendency," it would not be amiss to furnish a few descriptive words regarding the two volumes. *The Kinetic Drive* is a short monograph of seventy pages, a reprint of the Wesley M. Carpenter lecture, published a few months ago in the *Journal of the American Medical Association*. The main thesis is Crile's now well-known doctrine that the body is a mass of potential energy, and that the potential energy is converted into kinetic energy by various stimuli calling forth adaptive responses. After detailing this so-called kinetic mechanism, Crile dilates upon the functions of the adrenals and thyroids, and then, under separate chapter heads, considers the control of the kinetic drive, kinetic diseases (Graves' disease, cardiovascular disease, Bright's disease and diabetes) and surgical methods of controlling the kinetic drive, and finally, a summary. *Man, an Adaptive Mechanism*, is a more pretentious volume of three hundred odd pages, devoted to an expatiation of the doctrine that "man is essentially an energy-transforming mechanism, obeying the laws of physics, as do other mechanisms." A very readable introduction, containing not a few broad generalities open to question, is followed by a chapter devoted to man's adaptation to environment. Then follows Part II of the book, devoted to The Mechanisms of Adaptation, and finally, Part III, Biologic Interpretation of Phenomena of Health and Disease.

More specific or detailed statement is not called for, since our aim is merely to point out in general what books of this sort mean. And they mean just this, that the man who writes them is thinking briskly along lines somewhat divergent from the current of his "main" life's work. One would like to call them avocative books. They teach us the service of an avocation. Legitimate exception might be taken to our characterization of such effort as an avocation, but certainly no workaday operating room or surgical laboratory turns out such product. If for the sake of argument, we were forced to admit that these two books are distinctly surgical and represent ultimately the opinion of a surgeon on surgical disease, we should say: "Then let us have a few more just such volumes." These are days when men have to be forced to think and imagine, and Crile furnishes the most impelling stimulus to this end. Finally, even if I be constrained to view the books as pure surgery, I shall counter with the statement that they represent the artistry of surgery as contrasted with the artisanry of the usual book, devoted to the more specifically technical subjects of surgery proper.

HERE is a book[2] that speaks for itself and requires no comment from the reviewer, regarding the tendency that it manifests. One may be pardoned for entertaining the suspicion that everything everywhere is tending toward war. This much I know, that within the year I have had to rearrange my shelves several times in order to make room for new war surgery volumes.

Hull's book is practically along the same lines and after the same fashion as the volume by the

[1] The Kinetic Drive, Its Phenomena and Control. By George W. Crile, M.D. Philadelphia and London: W. B. Saunders Co., 1916. Man, an Adaptive Mechanism. By George W. Crile, M.D., New York: The Macmillan Company, 1916.

[2] Surgery in War. By Alfred J. Hull, R.F.C.S., with a preface by Sir Alfred Keogh, M.D. Philadelphia: Blakiston's Sons & Co., 1916.

Frenchman Delorme, the English work by Makins, the various contributors to the Oxford War Primers, and the treatise by the American La Garde. The difference lies in the fact that this, being the latest volume to appear, presents the latest conclusions reached by the English surgeons.

For example, the first chapter on The Bacteriology of Wounds in War summarizes very clearly Sir A. E. Wright's studies on wound infections and their treatment; and Chapter II on The General Condition of the Wounded summarizes admirably the data of the various collecting and base hospitals. Chapter III on The Treatment of Wounds, and Chapter IV on the Treatment of Wounds by Saline Solutions furnish about the only data that may be appropriated advantageously by the civil surgeon in his routine work. The remaining eleven chapters deal with surgery from the regional point of view and, although of unusual interest, hardly call for detailed comment, save to mention the salient fact that chest wounds are still handled along lines of the strictest conservatism, in contrast with wounds of the abdomen, which are being treated more and more radically (as regards early operation or exploration), in accordance with the rules that have been followed in civil practice.

There are several contributors to the little volume and they have done their work well. The book is built for the knapsack, and is built admirably for this purpose indeed.

A RECORD of accomplished purpose is not easily incorporated in a review of this latest product of Mr. Lane[1] or better, this joint production of Mr. Lane, Mr. MacMahon, and Mr. James, for the latter two gentlemen contribute chapters on Speech Training and Dental Treatment of Cleft Palate, respectively. Judging from the title, the book is ostensibly devoted to a consideration of the subjects Cleft Palate and Hare Lip. As a matter of fact, the latter is quite ignored save for a table showing the frequent coexistence of the two conditions, which table in itself sufficiently warrants more than merely casual reference. After a lengthy introduction, Mr. Lane reveals his purpose by emphasizing the two points which really represent the sum and substance of the entire book. The first is that cleft palate operations are to be done very early, and the second is that his method of operating by fashioning mucoperiosteal flaps is preferable to the simpler one of paring and co-apting the margins of the cleft.

In the light of illuminating experience surgeons very generally incline to accept the latter dictum as correct and concede to Mr. Lane well deserved credit for originating and popularizing so valuable an operation. They may well concur also in the first point to the extent of advising operation before dentition interferes with the reflection of adequate mucoperiosteal flaps, and before the child acquires permanent speech defects as speech develops. But it is possible that Mr. Lane presumes a bit in recommending operation upon the day of birth, or as soon thereafter as possible on the basis that "the newly born child is always healthy" (p. 34). It is well recognized that serious consequences may follow even the much simpler circumcision operation upon even slightly jaundiced babies.

[1] Cleft Palate and Hare Lip. By Sir Arbuthnot Lane, Bart., M.S., F.R.C.S., 3d ed., London; Adlard & Son, 1916.

A SHORT span of less than two decades has sufficed to place the problems of internal secretion into the very center of medical interest and to incite a countless number of students to devote their energies to this fascinating subject. Virchow's cellular pathology, once supreme and all-embracing, no longer seems to stand on its former firm foundation, and the camp of those who endeavor to establish the old humoral pathology on a new and scientific basis is daily growing larger. That such an unconditional defection is, to say the least, premature at the present day, will hardly be denied by the majority of medical workers. Yet, the accumulated mass of clinical and experimental evidence is so immense, and only exceeded by the number of more or less plausible theories, that it has been extremely desirable to possess a critical summary of our present knowledge of the nature and significance of the glands with internal secretion. Out of this need was born Biedl's monumental work on the experimental physiology and pathology of the ductless glands. This was followed by an equally important treatise by Falta[2] which first appeared in German in 1913 and now appears in English translation.

Falta has set himself the task to consider the clinical aspects of the diseases of the ductless glands, and his deductions and conclusions are based upon an exhaustive study of the literature and an exceptionally large number of personal observations. The opening chapter is devoted to a general consideration of the normal and pathological physiology of the ductless glands, their reciprocal action, their interrelations to other organs and their influence upon the constitution of the entire organism. There follow nine chapters dealing separately with the diseases of the thyroid gland, cretinism, affections of the parathyroids, thymus, hypophysis and epiphysis, lesions of the suprarenal apparatus, the status lymphaticus and hypoplasticus, and finally, diseases of the sexual glands. The last-named chapter comprises a consideration of the interstitial glands and a discussion of changes in the generative apparatus. This includes malformations, hypogenitalism (eunuchoidism), hypergenitalism, chlorosis, and osteomalacia. A short chapter is devoted to pluriglandular diseases. Infantilism, dwarfism, rachitis, chondrodystrophy, and mongolism are united in a chapter on vegetative disturbances that do not depend directly on diseases of the ductless glands. In another chapter, the diseases of the insular apparatus of the pancreas and their

[2] The Ductless Glandular Diseases. By Wilhelm Falta, Vienna. Translated by Milton K. Meyers, M.D. 2d ed., Philadelphia: P. Blakiston's Son & Co.

relation to diabetes are treated, and the final chapter deals with the different forms of obesity and adipositas dolorosa.

A comprehensive list of bibliographic references at the end of the book, covering no less than 69 pages, will prove of great advantage to anyone who wishes to study special subjects.

As can be seen from this brief survey of the table of contents, the field of study is enormously large, and Falta has endeavored to bring order into the existing chaos. His guiding principle has been this, that the diseases of the ductless glands altogether are due to quantitative alterations of the respective internal secretions; that is to say, either an increase or a diminution of function. Such a classification which leaves qualitative disturbances of secretions or perverted functions of the glands entirely out of consideration, is bound to create objections. Falta himself anticipates such opposition but he meets it by contending that the physiological chemistry of the internal secretions is still in its infancy. The author has endeavored to attack the difficult and complicated problem with strict objectivity. But in a field where our actual knowledge is still incomplete in spite of the imposing material collected, there is a great temptation for theories for which the convincing experimental and clinical proofs are still lacking.

In medicine everything is in motion, more so in this most modern branch of pathology than in other fields. Falta's book is not the last work; it is only a milestone in the development of the study of the internal secretions. The pathology of the hypophysis and the sexual glands, for instance, is only in its initial stage. The question of diabetes is still *sub judice*, and the veil has hardly been drawn from the obscurity of the nature of the pluriglandular diseases.

Yet, the value of the book cannot be overestimated. The astounding erudition, industry, and ingenuity of the author fill the reader with sincere respect. The work represents a permanent acquisition for medical literature, for it will act as an inspiring and fructifying stimulus upon other scholars to study the clinical aspects of the diseases of the ductless glands.

To have translated this work and to have put it within reach of English speaking students, was a laborious undertaking of great merit; the publishers, too, deserve their share of appreciation. The translator has still further increased the value of the book by collecting recent American and English views in an "addendum" at the end of nearly every chapter.

This is the second English edition, and it seems more than likely both from the far-reaching importance of the subject and the intrinsic worth of the book that a third edition will soon be needed. Under these circumstances the reviewer cannot refrain from expressing a friendly criticism as to the phraseology of the translation. Typographical errors and misspelled names of foreign authors will, of course, easily be corrected. The English title sounds awkward; "Diseases of the Ductless Glands" would seem preferable. More important, to my mind, is the all too faithful rendering of the German text. It seems unnecessary that the fact of its being a translation should be made so painfully obvious through an almost photographic reproduction of the involved German sentences, and the *genius linguæ* is offended if, for instance, the German *Krankheitsbild* appears before us as a disease picture. "Differentiation" is surely superior to "delimitation," a literal translation of *Abgraenzung*. *Ueberlaenge* should be "excessive" rather than "upper" length. A connection between two phenomena may be not clear or obscure, but not "unclear"; and it requires a thorough knowledge of the German language to discover that "coarsest misunderstandings" merely mean gross misconception. However, such defects are not incurable, and it may yet be in the power of the translator to make Falta's book an English classic.

A CORRECTION

NOTE. Dr. Frank Smithies has kindly called our attention to the fact that in the review of his recent excellent treaties on "Carcinoma of the Stomach," we were in error in stating that he did not mention the points of differentiation between cancer of the stomach and pernicious anæmia. The differentiation is given in a table of differential diagnosis, which unfortunately escaped our attention (pp. 403–4–5).

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

CANCER COMMISSION OF HARVARD UNIVERSITY. Third Annual Report of the Collis P. Huntington Memorial Hospital for Cancer Research, 1914 and 1915.

THE BASIS OF SYMPTOMS, THE PRINCIPLES OF CLINICAL PATHOLOGY. By Dr. Rudolph Krehl. Translated from the seventh German edition by Arthur Frederic Beifeld, Ph.B., M.D., with an introduction by A. W. Hewlett, M.D. Philadelphia and London: J. B. Lippincott Company, 1916.

THE MEDICAL CLINICS OF CHICAGO. March and May, 1916. Philadelphia and London: W. B. Saunders Company, 1916.

PERORAL ENDOSCOPY AND LARYNGEAL SURGERY. By Chevalier Jackson, M.D. St. Louis: The Laryngoscope Company, 1915.

THE PRACTITIONER'S MEDICAL DICTIONARY. By George M. Gould, A.M., M.D. Philadelphia: P. Blakis-

ton's Son & Co., 1916. 3d ed., revised by R. J. E. Scott., M.A., B.C.L., M.D.

DISEASES OF THE SKIN. By Richard L. Sutton, M.D. St. Louis: C. V. Mosby Company, 1916.

THE PRACTICAL MEDICINE SERIES. Series 1916, Volume II—General Surgery. Edited by John B. Murphy, A.M., M.D., LL.D., F.R.C.S., Eng. (Hon), F.A.C.S. Chicago: The Year Book Publishers, 1916.

DISEASES OF THE DIGESTIVE TRACT AND THEIR TREATMENT. By A. Everett Austin, A.M., M.D. St. Louis: C. V. Mosby Company, 1916.

SKIN CANCER. By Henry H. Hazen, A.B., M.D. St. Louis: C. V. Mosby Company, 1916.

ASEPTIC SURGICAL TECHNIQUE; WITH ESPECIAL REFERENCE TO GYNÆCOLOGICAL OPERATIONS TOGETHER WITH NOTES ON THE TECHNIQUE EMPLOYED IN CERTAIN SUPPLEMENTARY PROCEDURES. By Hunter Robb, M.D. 5th ed., revised. Philadelphia and London: J. B. Lippincott Company, 1916.

SURGICAL AND GYNÆCOLOGICAL NURSING. By Edward Mason Parker, M.D., F.A.C.S., and Scott Dudley Breckinridge, M.D., F.A.C.S. Philadelphia and London: J. B. Lippincott Company, 1916.

THE SEX COMPLEX. A Study of the Relationships of the Internal Secretions to the Female Characteristics and Functions in Health and Disease. By W. Blair Bell, B.S., M.D. (Lond.). New York: William Wood & Company, 1916.

DISEASES OF THE EYE. A Handbook of Ophthalmic Practice for students and practitioners. By George E. de Schweinitz, M.D., LL.D. (Univ. of Pa.). 8th ed. Philadelphia and London: W. B. Saunders Company, 1916.

COLLECTED PAPERS OF THE MAYO CLINIC, ROCHESTER, MINNESOTA. Edited by Mrs. M. H. Mellish. Volume VII, 1915. Philadelphia and London: W. B. Saunders Company, 1916.

GYNECOLOGY. By William P. Graves, A.B., M.D., F.A.C.S. Philadelphia and London: W. B. Saunders Company, 1916.

EMBRYOLOGY, ANATOMY, AND DISEASES OF THE UMBILICUS TOGETHER WITH DISEASES OF THE URACHUS. By Thomas Stephen Cullen, M.D. Philadelphia and London: W. B. Saunders Company, 1916.

THE MEDICAL ANNUAL: A YEAR BOOK OF TREATMENT AND PRACTITIONER'S INDEX. Bristol: John Wright & Sons, Ltd.; New York: William Wood & Co., 1916.

LATERAL CURVATURE OF THE SPINE AND ROUND SHOULDERS. By Robert W. Lovett, M.D. 3d ed. revised and enlarged. Philadelphia: P. Blakiston's Son & Co., 1916.

VENESECTION; A BRIEF SUMMARY OF THE PRACTICAL VALUE OF VENESECTION IN DISEASE. For students and practitioners. By Walton Forest Dutton, M.D. Philadelphia: F. A. Davis Company, 1916.

PRACTICAL MASSAGE AND CORRECTIVE EXERCISES. By Hartvig Nissen. Philadelphia: F. A. Davis Company, 1916.

A TEXTBOOK OF PRACTICAL GYNECOLOGY. For students and practitioners. By D. Tod Gilliam, M.D., and Earl M. Gilliam, M.D. 5th ed., revised. Philadelphia: F. A. Davis Company, 1916.

A MANUAL OF SURGICAL ANATOMY. By Lewis Beesly, F.R.C.S., and T. B. Johnston, M.B., Ch.B. New York: William Wood and Company, 1916.

INFECTIONS OF THE HAND. A Guide to the Surgical Treatment of Acute and Chronic Suppurative Processes in the Fingers, Hand, and Forearm. By Allen B. Kanavel, M.D. 3d ed., thoroughly revised. Philadelphia and New York: Lea & Febiger, 1916.

OPERATIVE MIDWIFERY. A Guide to the Difficulties and Complications of Midwifery Practice. By J. M. Munro Kerr, M.D., C.M. 3d ed. New York: William Wood and Company, 1916.

OBSTETRICS, NORMAL AND OPERATIVE. By George Peaslee Shears, B.S., M.D. Philadelphia and London: J. B. Lippincott Company, 1916.

CEREBELLAR ABSCESS; ITS ETIOLOGY, PATHOLOGY, DIAGNOSIS, AND TREATMENT, INCLUDING ANATOMY AND PHYSIOLOGY OF THE CEREBELLUM. By Isidore Friesner, M.D., and Alfred Braun, M.D., F.A.C.S. New York: Paul B. Hoeber, 1916.